



INTERNATIONAL LABOUR ORGANIZATION
UNITED NATIONS EDUCATIONAL, SCIENTIFIC
AND CULTURAL ORGANIZATION



CEART/12/2015/6

Joint ILO–UNESCO Committee of Experts on the Application of the Recommendations concerning Teaching Personnel (CEART)

The implications of technological change on the teaching profession
by Josep M. Mominó, Internet Interdisciplinary Institute (IN3) UOC

Background paper for discussion at the 12th Session of the CEART
(Paris, 20–24 April 2015)

Paris, 2015

UNESCO – PARIS

ILO – GENEVA

Contents

SUMMARY	3
HOW TECHNOLOGY IS CHANGING EDUCATION IN SCHOOLS	4
PEDAGOGICAL IMPLICATIONS	5
REVIEWING THE FACTORS THAT LINK PEDAGOGICAL PRACTICE	6
REVIEWING SCHOOL ORGANIZATION	7
REVIEWING THE SCOPE OF NETWORKED EDUCATION ACTIONS	8
THE IMPACT OF PEDAGOGICAL CHANGE ON THE TEACHING PROFESSION	9
ICTS IN AN ALTERNATIVE VIEW OF THE ROLE OF TEACHERS	10
ICTS AND NEW FORMS OF ORGANIZATION FOR THE TEACHING PROFESSION	12
ICTS AND THE TEACHING PROFESSION'S OPENNESS TO NETWORKS	13
CONCLUSIONS AND POLICY IMPLICATIONS	14
ICTS POLICIES FOR A NEW PROFESSIONAL ENVIRONMENT	15
ICT POLICIES FOR NEW FORMS OF TEACHING	15
ICT POLICIES FOR PROFESSIONAL NETWORKING ACTIVITY	15
REFERENCES	17

Summary

Despite enormous expectations, ensuring that information and communications technologies (ICTs) become an effective instrument for innovation in the education sector has not been a simple or automatic process resulting from placing ICTs in the hands of teachers. The difficulty lies in the complexity of schools appropriating this technology with a broad vision of what they can contribute to innovation when incorporated into the links between education and a networked society in a globalized world. This very complexity explains why the impact of ICTs in other areas of society and the economic system has been so limited in terms of transforming the teaching profession. The potential impact of ICTs on day-to-day teaching activities is inextricably linked to the need to build a professional space that is more suited to education parameters being developed and therefore more flexible and open to network collaboration (with greater opportunities for teacher creativity and initiative). This development is largely dependent on schools being seen as organizations able to respond to the challenges of the twenty-first century and becoming a valid reference point for young people. This development is ultimately dependent on the teaching force becoming an attractive profession that can rise to the challenges of education in the knowledge society.

How technology is changing education in schools

We live in a world that is undergoing a process of rapid and far-reaching change. Our time is one of major challenges, great promise and immense opportunity. In developed countries (as well as emerging and more disadvantaged nations), daily life takes place in forms of social organization that are changing dramatically. Patterns of activity established under industrialization and those still linked to farming are being gradually replaced by new forms of social expression suited to new models of economic and cultural production. This social and cultural reconfiguration, or what is known as the “network society” (Castells, 1999), is gradually basing itself on a new economy based on knowledge-production (with ICTs as the essential bedrock for development). The ability to learn and innovate forms the raw materials driving the knowledge economy. Each person’s potential creativity has become the main resource and the force behind this transformation (Florida, 2004).

To adapt to these new circumstances, individuals and organizations must take on new challenges, and it is in this context that education has become a key player. In most countries and regions worldwide, governments have become aware that effectively organizing education should be a strategic priority for economic growth and social cohesion. The dynamics of the knowledge economy only make sense when intrinsically linked to education (Dale, 2005). The aim is to move from a mass-production model with a hierarchical organization, to one in which value is placed on using more flexible network collaboration to create new knowledge, with the work of individuals increasingly focused on solving complex problems requiring a sophisticated use of information and decision-making based on high levels of personal judgement, initiative and autonomy. Determination to progress in this direction requires change to the fundamental components of education systems: what should be taught but also how to teach and learn, as part of organizational arrangements that schools can adopt to provide educational experiences and settings that can respond to these demands. Obviously, the demand for change is also targeting the traditional set-up of the teaching profession (which is one of the most crucial factors in this process).

Research into “effective schools” has identified a series of factors critical for how they function (Sammon et al., 1995). However, we do not yet know if this set of distinctive features will also guarantee the effectiveness of schools in the new and complex environment of the knowledge society. Although the idea of schools as “learning organizations” includes the tacit ambition to make the school meet the requirements of this new social model, the concept is still not developed enough to offer anything more than a vague idea of what this new shape for the sphere of teachers’ professional activities will look like. This context of uncertainty is the backdrop for the huge amount of trust that has been placed in the potential of ICTs to contribute to educational innovation. Such high expectations come from the privileged position of technology in preparing active participants in the globalized labour market, as well as in shaping more flexible, open and efficient educational institutions as a contribution to teacher effectiveness and productivity (Pedró, 2011). However, the crux of the matter is that the full potential of ICTs can only be fully unlocked if these tools are used as part of a new pedagogical paradigm in which school functioning looks very different from most examples seen today (Kozma, 2011).

The characteristics that should define these schools wishing to adapt to the requirements of the knowledge society are only just beginning to be identified (Hargreaves, 2003; Schrum & Levin, 2009). Teachers will be expected to play a very different role from the one they have traditionally fulfilled, because the pupil must take the lead in pedagogical practice. The teacher’s main task will be to create the most conducive conditions and use the most suitable means of enabling all pupils to apply various learning strategies to create their own knowledge outcomes in differing situations. In such a complex task, ICTs can undoubtedly be seen as a powerful ally for teachers. However, this innovative potential also has a flipside. A genuinely effective incorporation of ICTs in the classroom involves gradually leaving behind the obsolete practices and conditions of the old pattern as part of a process of “creative destruction” (Kozma, 2012).

Only by considering all the factors involved in the dynamics of this process can we begin to understand schools' difficulties in embracing ICTs as part of their daily activities. To date, steady growth in government investment in hardware for schools and the rapid development of connectivity rates (OECD, 2006) have yet to empirically demonstrate that this approach is being reflected in improved academic results among students (Fuchs & Woessman, 2004; OECD, 2006, 2010, 2011). The examples that do show how technology has helped to create innovative learning environments (Dumont et al., 2010) are far from being part of a prevailing trend. Schools change slowly, and what is known of this dynamic suggests that the main obstacle often lies in changing the DNA underlying classroom activities (Cuban, 1986; 2001; 2012). In other words, this refers to the conventional and institutional notion of teaching practice to which teachers have adapted their daily professional actions, which consist in a repertoire of teaching practices mainly based on teacher activity (rather than student activity). This "school grammar" (Hargreaves, 2000; Tyack and Tobin, 1994) that (as with linguistic grammar) structures pedagogical practice is often the main obstacle to overcome. Technical resources are rarely the main hindrance in terms of a school's difficulty in effectively embracing ICTs in all its spheres of activity. The effectiveness of technology is always dependent on the nature of its organizational, social and cultural framework. The true potential of technological tools lies in the strong contribution they can make to creativity when it comes to considering the future challenges for schools (as well as those facing schools nowadays).

The capacity of education systems to adapt to the new social order depends not only on how much schools use Internet, but also relates to how they can embrace technology to respond to demands that – with the arrival of technology in everyday life – arise from a global economy and the impact on production processes, market globalization, labour-market flexibility and transformation, the redefinition of family/community and new forms of migration (Carnoy, 2002). In this uncertain context of rapid change, varied types of modern society are seeing gradually increasing pressure on schools (and ultimately teachers) to find new forms of organization and teaching models to enable young people to acquire the knowledge and skills needed today. The ultimate aim is to promote teaching models and learning environments that can enable new generations to learn how to use relevant technology and – continuously and independently throughout their lives – acquire the skills needed to participative actively in complex modern society (OECD, 2012).

This is why many teachers find themselves needing to develop new teaching strategies (without any improvement in working conditions), while also seeking new forms of collaboration, organization and participation to formulate and share experience and knowledge within their professional setting. Taking up the gauntlet of learning how to educate citizens to be equipped for the knowledge society (without any pre-defined models and using today's technologies) involves reviewing the traditional definition of teaching and shifting our view on career development in the light of the challenges for today's schools and those of tomorrow (MacBeath, 2012; Schleicher, 2011). The aim of this document is to draw attention to one of these factors. This study seeks to emphasize how the incorporation of ICTs influences the vision of the professional sphere and the perspective on development, in the light of the position of these technologies as a teaching instrument in some of the possible iterations of education in the future (Istance, 2006).

Pedagogical implications

Throughout the world, education systems are seen as one of the main tools that countries and regions (along with their specific characteristics) use to be part of the knowledge economy and to increase social cohesion and levels of well-being. In this context, the expectation of the contribution of ICTs to educational innovation has been extremely high. The deterministic approach took it for granted that installing these technologies in schools would guarantee the training needed in today's world for new generations, while leaving behind the patterns established by industrialization. This view considered that ICTs would be strong enough to drag schools (and teachers themselves) towards much-needed innovation.

However, as shown by the knowledge we have on the dynamics of this process (Partnership for 21st Century Skills, 2005), several decades of sustained investment in schools' technological resources and the trend towards universal Internet access have not resulted in enough tangible evidence that the general change needed has happened. To date, it has become clear that technologies have huge creative potential and can also be versatile and flexible for other uses. Therefore, teachers have often adapted ICT use to traditional forms of understanding teaching, with schools using them to maintain conventional organization rather than taking on new organizational solutions from the network society (Gordó, 2010). In this sense, technology has become an extremely soft tool when trying to integrate into a hard structure such as a school (Sancho, 1996) (or more precisely into the institutionalized "grammar" of schools (Hargreaves, 2000; Tyack and Tobin, 1994) that was described above as governing daily teaching practice).

Teachers' notions of their own professional activity have been shown to be fairly rigid, as well as being stable and constant over time. Although there are many indicators of widespread dissatisfaction with the quality of education systems, schools seemingly remain more prepared to face the challenges of the twentieth (rather than twenty-first) century. In this context, ICTs are often used to continue a school's culture of making no distinction between teaching and explaining, learning and listening or knowledge and book learning. It should be borne in mind that teachers nearly always find it easier to incorporate technologies into their teaching methods (rather than altering the latter) than to ignore implicit convictions and risk implementing alternative teaching strategies that often fail to match the organizational structure of a conventional school (Pelgrum, 2001; Cuban et al., 2001). To rise to this challenge, teachers remain a key player, and ICTs can be a powerful ally in transforming the profession. Although this is undoubtedly the greatest technological challenge that teachers have had to face, it must not be forgotten that the only way of harnessing the potential of ICTs is for teachers to learn to use them creatively for the benefit of those visions of education that place students at the heart of the process and reconsider the position of knowledge, schools' forms of organization and links with the education community. The characteristics of each component should be considered for a full understanding of the nature and scope of the resulting redefinition demanded of the teaching profession.

Reviewing the factors that link pedagogical practice

Global changes under way in modern societies are being reflected in alterations to the forces that have traditionally defined learning. These transformations are so dramatic that it would be difficult for teaching methods to remain unaffected. One of the most substantial changes is the time scale for education. The current situation shows that education can no longer be seen as a process that is developed and completed at the beginning of the life cycle. In the knowledge society, it is a process that extends beyond initial education into all stages of life (UNESCO, 2008a). The new dimension is not only about extending out over time: the learning process itself has broadened out into a huge variety of new contexts. The potential of ICTs to offer new settings, interaction opportunities and learning tools has been fundamental in redefining the axes of education (in terms of its length and breadth). In this regard, ICTs have made a crucial contribution to shaping a new "learning ecology" (Coll, 2013a; Barron, 2006). ICTs have broken down the barriers of time and space that used to define the limits of pedagogical practice. The learning experience is thus no longer limited to a specific place or time, and has become enormously flexible. In addition to the freedom that this has provided in terms of learning opportunities in more diverse everyday situations, ICTs have also given us very powerful tools for seeking and combining information, as well as resources for representing knowledge, interaction and collaboration that are playing a crucial role in the reshaping of teaching and learning processes described herein.

It is also worth remembering that it would be impossible to reposition pedagogical practice in these new parameters without changing the contents. The capacity for continuous lifelong learning (and also through an increasingly wide range of contexts and technological resources) has gained strategic value in our society. The memorizing of specific facts and the ability to reproduce simple procedures are losing ground to the need to orient learning and teaching towards the solving of complex problems that are comparable to real situations. The capacity for teamwork, networking

and using technology skills to access information (but mainly to manage information to generate knowledge) are becoming the main skills required in the 21st century (Partnership for 21st Century Skills, 2005, 2003; International Society for Technology in Education [ISTE], 2007; Kozma, 2009; OECD, 2009a; Trilling and Fadel 2009; European Commission, 2010). Creativity and entrepreneurship (Zhaho, 2012) have become the emerging values for the lifestyle and work life of our times. Unsurprisingly, curricula are gradually shifting their emphasis towards complex interdisciplinary knowledge and the type of skills needed to work on crosscutting projects. It is precisely in such areas that ICTs can fulfil their potential by facilitating processes to create and generate shared knowledge that goes beyond the frontiers of individual disciplines.

The major role played by technology in all areas of daily life also has repercussions for the definition of education content. The increasingly universal access to the Internet and the ubiquitous ICTs in the world of “new millennium learners” (Pedró, 2006; OECD, 2010) are gradually changing conventional forms of accessing information (as well as the ability to use information with sophisticated tools to combine multimedia formats to represent and share knowledge or create new cultural products). The early stages of the process (in which digital literacy was incorporated into the curriculum) have given way to a wider integration of ICTs (which are mainstreamed across all areas of knowledge to provide symbolic language used for learning in all disciplines). The school must therefore revise the traditional notion of literacy to take up a new wider and updated definition relating to the acquisition of the know-how and knowledge needed to play an active part in the culture of the knowledge society (Williamson, 2013). Although schools must be able to continue providing basic knowledge for general use of technology, they will not make full use of ICT potential if they do not learn how to teach young people to get the most out of staying informed and communicating in order to play, create and ultimately learn autonomously beyond school and in various contexts (Sharples et al., 2012). This is a prerequisite for active and responsible involvement in the network society.

Reviewing school organization

The changes to factors behind pedagogical practice and, more generally, the huge importance that learning has taken on as part of people’s lives and institutions in the knowledge society pose a major challenge in terms of adapting traditional school organization (and by extension the operational dynamics of education systems). This organization and its operational dynamics correspond to the outgoing model of society and the economy. This disconnect generates dissatisfaction within some education systems, in which repeated attempts at reform have failed to come up with sufficiently innovative ways of tackling the complex challenges posed by society in the globalized world.

The rigidity, hierarchy and separation between departments that characterize organizational structures in the industrialized era have gradually proved to be ineffective in a post-industrial context and in the face of the demands of a knowledge economy. Flexibility has become a crucial aim of new organizations, not only to be able to adapt to a rapidly changing context, but also because of the importance they attach to providing favourable conditions in which everyone involved can contribute skills and creativity towards the ongoing development of the organization (Carnoy, 2002). However, most schools maintain a static culture of organization where knowledge to be imparted is predefined in highly structured curricula, the main source of knowledge is a textbook and teachers take the lead in the classroom (with students seen as recipients with limited scope for personal initiative, communication and cooperation on shared projects due to the static context based on traditional values of order and discipline). This type of organization is increasingly unable to offer the sort of education demanded by a constantly changing globalized world (Bauman, 2003). Schools have not yet become dynamic enough to replace an obsolete model of organization with an example of functioning befitting that of a twenty-first-century organization. Teachers rarely have a space to move beyond traditional dynamics and collaborate creatively in developing professional knowledge (Hargreaves, 2001) in a way that would ultimately improve education quality.

The vital role now played by knowledge in society, the transformation in the parameters of learning and the huge range of opportunities provided by ICTs have placed schools in a qualitatively new and unstable position. In order to respond to the speed and complexity of change, schools need to be able to adopt a versatile organization (Martín-Moreno, 2010) with flexible operational structures and multipurpose environments that adapt to necessarily diverse and changing educational proposals. These organizational solutions should facilitate the design and development of new pedagogical approaches that transcend predefined teaching content to place individual learning processes and knowledge transfer capacity at the heart of educational action. The emphasis on individualized learning (and the personalization of teaching) requires malleable curricular structures that can adapt to diverse needs and interests, so as to gradually leave behind the uniform lesson plans of traditional schooling. With this in mind, the organization should facilitate a flexible grouping of pupils that simultaneously combines individual work or teamwork depending on the range of activities and projects under way at that time. School time and space need to be organized in a way that responds to this versatile concept and slowly moves away from rigid timetables while seeking alternatives to existing architectonic limitations to provide suitable learning environments that can dynamically adapt to the changing nature of activities. These environments must basically be able to facilitate the autonomous work of students.

Ultimately, this dynamic calls for organizational evolution from the current approach of instructing good pupils, towards an alternative function promoting the training of competent learners (Coll, 2013b). Current education systems (and schools) have mostly directed their efforts at producing students able to assimilate the various types of curriculum content. The effectiveness of these systems is therefore mainly measured by observing the extent to which that content has been learned. However, at a time of expanded learning dimensions (across the lifetime and various contexts beyond school), it appears that the dynamics of these institutions cannot remain unchanged. Alternative forms of organization are crucial if young people are to harness this vital early training to continue learning effectively and to be able to meet new requirements.

ICTs undoubtedly provide powerful tools that can be used for the kind of flexible and adaptable organization required today. From this perspective, technologies should be seen as an ally for innovation that provide alternatives to overcome the rigidity of traditional school structures: fragmentation of time slots and compartmentalization of physical space to separate areas of knowledge and the independent work of teachers and sets of pupils. It is essential to find new strategies and instruments so that the organization can truly serve specific crosscutting projects aimed at delivering genuine personalized and interdisciplinary learning situations that are open to collaboration within and outside school. In order to break down such organizational barriers, ICTs offer an increasingly wide range of instruments for accessing or handling information, networking and generating or representing knowledge with no restriction of space or time. In any event, a study of this process (Cuban, 2012, 2001, 1986) shows that harnessing these opportunities is less dependent on the potential already offered by these technologies, and more based on the conditions that education systems and schools can create to promote teachers' creativity in using these tools for innovating and improving education quality (rather than continuing what they have done before). The challenge facing schools is being able to become education organizations with the ability to learn (Santos, 2010; Senge et al., 2000). With that in mind, these institutions must be able to make ICTs available to all actors in the education community to experiment and collaborate as a network in producing new shared knowledge on pedagogical innovation (Davidson and Goldberg, 2010).

Reviewing the scope of networked education actions

The gradual adoption of networks as a structural and operational part of our society (Castells, 2000), and the key role of ICTs in driving this process, tend to put pressure on the ways schools function and progressively blur their traditional organizational outlines. In addition, the nature of social change has also impacted the changing coordinates of school education (and this also stretches the notion of education content, as stated earlier). The point is that altering the time and

space parameters not only influences curriculum setting and organization, but also blurs the outline of what defines education actions.

Schools have often developed their activities with some limited contact with the environment (and sometimes outside their setting). Links with families tend to be occasional and limited to very specific times and subjects. External links with associations, entities, companies, universities, other schools, professionals or cultural representatives are very rare. In fact, links to the outside world are often limited to those required by the rules. This closed-off situation promotes a disconnect between what happens in the classroom and the daily lives of young people outside school. However, the new social order has extended the learning window almost indefinitely. This has also involved breaking the spatial boundaries of education activity, which could be seen as a functional break in terms of the school's scope of action and the dimensional focus of the actions of teachers. In today's world, there is less and less of a distinction between those who have, build, disseminate and transmit knowledge. In a social and economic activity like teaching (which is so closely linked to accessing and combining information and the crosslinked production of knowledge), it is increasingly difficult (not to mention inappropriate) to restrict it to specific institutions or groups of activity. Knowledge is spread throughout the network, where an abundant mix of actors distributes information and knowledge and produce cultural products. Young people can use ICTs and their mobile devices to access this information anytime, anywhere (and mainly outside school). They thus have the opportunity to access a wide range of learning environments and resources, establish a broad network of contacts and take part in various forms of networked activity that happen on a daily basis.

Schools and their professionals (as with other institutions in society) cannot easily remain on the outside of this process. Schools must redefine their activity through personalized education that can guide each student's training on the basis of the learning experiences and situations from his/her everyday life. With this in mind, schools must permanently abandon their position as enclosed areas to learn to be open enough to interact, forge cooperative links with various actors serving as education agents (Enguita, 2008; Gordó, 2010) and act as a hub for many forms of outreach project (Davidson & Goldberg, 2009, 2010) through new networks that generate innovation and transfer it to all nodes in the system as a whole – rather than just schools (OECD 2009b, 2003; Hargreaves, 2003b). This two-way rapprochement is based on mutual interest and the generation of a new network of cooperation formulae. In this dynamic, the environment (beyond its own requirements or needs) becomes a source of resources and opportunities. The challenge for schools and their professionals is identifying the potential of the environment, learning how to mobilize various actors and generating collaboration projects that will ultimately help to innovate and improve the quality of education that schools can offer.

The impact of pedagogical change on the teaching profession

The new orientation of the format of education system activities and the appearance of ICTs as an opportunity for pedagogical change highlight the fact that the teaching profession needs to find a place for itself within these new parameters. Before the end of the last Millennium, the *Report to UNESCO of the International Commission on Education for the Twenty-first Century. Learning: The Treasure Within* stated that this would be one of the main issues: teaching content needs to be able to turn these technologies into real tools, and this involves teachers being able to question their own pedagogical practices (UNESCO, 1996). In this context of rapid change, the teaching profession in many countries feels pressured to change. Schools are being expected to train young people in the type of competences demanded in a knowledge society. Teachers can see the need to find new teaching methods that are different from what they were taught (and different from models passed down in their own initial training). Indeed, the professionals in education institutions are beginning to see (as in other areas of society) that they will have to find new organizational solutions to adapt to the demands of the new environment. The effect of this pressure has not yet resulted in any expected change. The profession changes slowly, probably because – as stated at the outset – the grammar defining the basic structure and activity of schools has historically been so stable as to curb any innovation (Hargreaves, 2000).

However, the challenge remains, and teachers are the key for building bridges of innovation to connect traditional schools with what is needed in today's society. Young people need to have advanced models of functioning, rather than just obsolete forms of organization. Beyond adapting their actions to how the system functions, teachers should also play an active part in designing and developing flexible forms of professional activity that can be used as a reference point by pupils. The aim is to help generate the kind of working dynamic and ways of using technology that are more valuable for a world where knowledge is and will be the main resource (and the ability to use knowledge creatively becomes the main source of progress). From this perspective, teachers in the new millennium must come to see themselves as a profession for creatives (Hargreaves, 2001), in which capacity for self-reflection, production of shared knowledge and the application of innovation become an integral part of their everyday professional activity. In order to move towards this notion of the profession, it is particularly vital to incorporate ICTS to the extent that teachers are able to use these tools for innovation and ultimately their own professional development (UNESCO 2008b).

In any event, a redefinition the teaching profession is contextualized within specific practice circumstances. In addition, it will always be a gradual process (precisely because of those circumstances). Development follows two inextricably linked paths. First, there are the "ages" of the profession (Hargreaves, 2000), ranging from the less technically demanding "pre-professional" stages to more advanced concepts of a profession requiring new competences to respond to the challenges of a networked society and a global world where learning and knowledge have taken on a new dimension. The second path of the profession's development is the incorporation of ICTs into education systems until schools are able to obtain greater value added and implement the technologies in a way that optimizes the contribution to education innovation (UNESCO, 2002). Teachers' adoption of ICTs should therefore be seen as a dynamic that is closely linked to their own professional development. The process can be seen as a ladder (Kozma, 20011, 2012) with different steps ranging from the most basic models of education to rungs where education can have a more effective impact on social cohesion and economic development as part of the knowledge society. The highest rung of the ladder is where teachers can use technology for network collaboration, ongoing learning, knowledge-based innovation and ultimately for improving the quality of education.

Without losing sight of this evolutionary concept, let us turn our attention to how the profession can redefine itself in those higher stages. With this in mind, the analysis will now focus on each sphere of professional action mentioned in the previous paragraph. The aim is to identify how reviewing the factors that link pedagogical practice, school organization and the expansion of education actions should be reflected in a gradual redefinition of the teaching profession and teachers' working conditions.

ICTs in an alternative view of the role of teachers

Probably one of the most important reasons behind the need for ICTs to work for teachers is precisely the need to improve the teaching process, while also reviewing and updating what is learned to match the requirements of today's society. Using ICTs for improving professional performance (beyond the interest in technology itself) should be part of an approach to teaching innovation as the combined result of a complex series of factors that converge to form pedagogical practice. In this process, the factors change and adapt as a result of the interactions, or eventually curb innovation (and prevent any possible improvement in professional practice). Although the basic axes of learning parameters have shifted substantially (with a change in content itself), innovation in the use of ICTs is dependent on teachers being able to assimilate these changes and incorporate technologies into their daily activities in a creative way to adapt to the specific characteristics of the new context.

As part of this complex vision of innovation, effective adoption of ICTs by teachers requires an in-depth review of traditional teaching culture (and this will never happen simply by being in contact with technology). This is a re-envisioning of the main frameworks of school education and requires

the participation of the entire education community driven by a systemic vision of innovation (OECD, 2009b). Teachers can adopt ICTs as a tool for innovation when they are able to appropriate these instruments and use them as part of specific strategies aimed at resolving some of the tensions involved. The potential of ICTs for transforming the profession is dependent on some of the main precepts of the wisdom of practice (rooted in schools' DNA and the traditional notion of teachers and their working conditions) being subject to review (Cuban, 1986, 2012). This review concerns some of the principles that guide teachers' actions and shape their ability to coordinate ICTs in innovative pedagogical actions.

The first of these principles is the position of the teaching process, and the resulting responsibility allocated to pupils in the learning process. The emergence of the network society has, *inter alia*, given rise to new environments (as well as alternative settings and times) where young people can find learning opportunities using sophisticated communication tools and unprecedented resources for accessing information and representing knowledge. In this context, it becomes increasingly difficult to ignore the uniqueness of each student's journey through various learning experiences and settings within and outside school. As a result, teaching methods based on uniform inputs become ever more difficult to defend. The alternative is for teaching to be able to roll out a range of teaching strategies providing diversified attention for each pupil's ability to learn and to shape the specific training process. In this sense, teachers' professional activities should aim to design personalized teaching methods based on the uniqueness of each student to promote autonomy in terms of driving the education process and maintaining it over time. It is hard to see how this seemingly difficult and complex task can be taken on without ICTs. The role of teachers will be to build methodologies and support work dynamics suited to specific projects, while selecting the most suitable technological resources on a case-by-case basis to create collaborative environments for complex problem-solving in real situations.

Second, the redefinition of the role of teaching also involves reviewing what to learn and why. The concept of teaching founded on the traditional idea of stable school knowledge divided into subjects and presented lineally and free from the social context of young people in their daily lives is losing ground. There is a need for professional actions that are not only defined by a single curriculum. It is essential for teaching to diversify its actions to connect with the necessarily diverse interests and needs of students. Beyond the need for flexibility, there is also the challenge for teaching purposes and contents of the wish to educate young people to be able to play an active role in a society in which information processing and access to knowledge have become the main resources in our creativity-based economy (Florida, 2004), and where ICTs offer the means to design, distribute and use new cultural products that drive sustainable growth. In this context, where the need for training is a lifelong feature, teaching must move beyond set contents to incorporate other crosscutting skills (Partnership for 21st Century Skills, 2005; European Commission, 2010). Apart from the pupil's subject-based knowledge, teachers must also emphasize what a student can do with what he/she knows (and mainly the resources and strategies that can be used to continue learning autonomously). For these purposes, ICTs are a powerful ally for teaching. Teachers can have an essential instrument for professional practice that offers powerful tools for organizing education activities, analysing information, communicating with students, collaborating with other education community actors and devising personalized environments for the pupils to use the tools and resources they need to implement their learning strategies. Lastly, such an incorporation of ICTs into teaching activities could clash with the assessment and accountability procedures often aimed at reproducing data, concepts and definitions to master sets of predefined knowledge. Innovation requires new and more complex assessment methods that do not predefine from the outset what a pupil must learn as a result of education, but rather focus on the personalized learning process to identify the educational value (throughout the process and upon completion) for each person and the collaborative group. For this view of assessment, technologies provide teachers with a huge range of potential options to gather evidence of skills demonstrated by pupils in solving new problems, generating new means of communication and collaboration and developing technological skills through these educational experiences.

Above and beyond this review of some of the basic components of traditional teaching culture, adopting ICTs for teaching activities also involves changes to the inventory of signs and types of language that characterize and shape professional practice. The use of ICTs as a teaching tool involves widening the range of symbols used by the teacher. Digitization of information has greatly facilitated the integration of diverse audio-visual formats into the teaching and learning process. The teaching experience is thus shaped by the multimedia language used to present information and represent knowledge using specialized technological solutions that are often suited to the needs of a specific subject area. The gradual digitization of the language of teaching introduces new forms of mediation in learning experiences, and therefore demands new competences from teachers (UNESCO, 2008b). As part of this process, teachers become expert learners who, beyond knowing about the generic functions of ICTs, learn to use them to gradually transform their teaching through innovation.

ICTs and new forms of organization for the teaching profession

Revising traditional school organization appears essential for effectively incorporating ICTs in a way that responds to the demands of the knowledge society. In order to make progress, one of the main challenges is the ability of teachers to adjust their professional activity to new forms of organization and to embrace technology for this purpose. The rigidity that has defined schools' physical structures, fragmentation of time, social organization and general dynamics looks increasingly dysfunctional. Flexibility has become a prerequisite for school organization that can adapt to a constantly changing environment and – above all – to the nature of the activity that must occur within schools. The aim is to adopt an organizational solution that enables teachers to change their practices and traditional expectations on pupils while contributing to innovation and ultimately their own professional development. The importance of promoting such organizational conditions is highlighted by the fact that it is hard for school innovation to take root when it is of external origin using a top-down approach and not based on teacher initiative.

Effective adoption of ICTs that is able to transform pedagogical practice is not governed by a different logic. It is therefore vital to generate flexible forms of organization in which teachers are more than just implementers and feel encouraged to take the initiative on collaboration projects (with the necessary support for their innovation proposals). In order to adapt to these flexible new educational institutions, teachers must be able to shift from a basically static professional culture to a more dynamic one. This complex evolution involves a starting point of teachers as protagonists and students as recipients disconnected from the context, with little room for interaction, communication or collaboration. Alternative forms of action often do not fit in with a notion that sees them as unsuitable in its conventional order. In this kind of professional culture, knowledge is defined by a pre-set curriculum and fixed in textbooks. The main role of teachers, and school organization as a whole, is to ensure that students assimilate this content that is considered fundamentally stable. The student's active participation in reformulating this knowledge is not the teacher's main mission, and school organization is not focused on this objective either. The pupil is seen as the recipient that the teacher should fill with predefined content that is basically located in the textbook.

It is through a reformulation of these traditional teaching parameters that the concept of the profession can evolve as part of new and more versatile forms of educational organization (Martín-Moreno, 2010) that can harness ICTs for educational innovation. First, for students to become protagonists in their own learning journey requires teachers to look to more personalized teaching methodologies. Making progress towards this new role for teachers requires curriculum design to be less uniform and more adaptable to diverse interests, needs, paces of learning and trajectories. There is therefore a need to have arrangements and instruments that are compatible with this proposal to facilitate assessment of the type of competences demanded by modern society and to guide all of the learning trajectories that converge in the school's day-to-day activities. This approach will result in professional practice that can simultaneously include different ways of working, periods of time and rhythms in the same organization (adapted to the specific characteristics of each activity or project under way). Participation in this dynamic requires

flexibility in the grouping of students, so that the conventional organization of class groups does not become an obstacle. Participation also requires a rethink of the conventional formula of the independent and self-sufficient teacher. Thus, teaching becomes to be gradually understood as a team action, with the professional sphere increasingly defined as a space for exchange and collaboration on interdisciplinary projects that can have many different forms and time scales.

The use of ICTs has become a crucial factor in creating this flexible, dynamic and collaborative workspace. In this context, experimenting with new teaching methods becomes a specific part of the teacher's daily activity. However, this is not yet a process that can occur in isolation based on the individual work of each teacher. The innovation activity that is increasingly permeating the profession is based on crosscutting forms of collaboration linked through interactions in professional networks involving colleagues and other experts. Insofar as teachers can use interactivity to generate new shared knowledge and identify strategies for innovation in pedagogical practice, schools will gradually become professional learning communities (Dufour, 2006; Senge et al., 2000). This process happens when school organization provides the right conditions for professional knowledge capital (the most obvious) and tacit knowledge to be recognized, shared and disseminated within the school and beyond its boundaries.

In a network society, gradually and deliberately linking teaching activity with this explicit and collective knowledge creation could be seen as one of the main focuses of the transformation of the profession. The unquestionable contribution that ICTs can make to this development is less dependent on technology itself than on the range of competences teachers can use to embrace the huge networking potential of these tools in an open process of generating new professional knowledge. This dynamic provides students with the a working model that fits in with the type of education required today. Schools able to create these working conditions have begun to act as learning organizations (Senge, 2006), with a culture clearly geared to personalized learning and ultimately to a decisive promotion of teachers' professional development.

ICTs and the teaching profession's openness to networks

The need to revise the scope of schools' education actions has arisen as a result of the rapid dispersion of goods, resources and cultural products that – in the knowledge society – have forever ceased to be considered the main heritage of educational institutions. Pupils and their families have access to a wide range of cultural products that can be used as educational resources (even though they have not been developed in a school context). Today's children and young people are already using these resources in their daily lives, and schools have yet to rise to the challenge of recognizing and guiding these increasingly diverse individual learning journeys. In a technological world with mass access to information, it is becoming pointless to try to limit children's learning to the school experience. These technologies can help schools become more permeable institutions if the organizations and their professionals learn to be connected to an environment that offers as many opportunities as it imposes requirements. Professional activity is becoming increasingly focused on the challenge of linking these actors to specific education projects. This is a process in which the traditional roles and boundaries of the teaching profession are becoming blurred.

Most information and knowledge today is on networks, where it is rapidly and constantly regenerated. It would be pretentious of schools to aim to store or control this content. With this in mind, driving initiatives in the education sphere increasingly requires the participation of external people, groups and organizations. Schools are being pushed to seek ways of achieving egalitarian collaboration with a wide range of actors from outside the organization. These external individuals or institutions may be willing to work on education projects because of shared objectives relating to their sphere of specialization. As a result, they often already have their own mechanisms for disseminating their activities and sharing the resulting knowledge (that can easily be linked up with the objectives of the school). Establishing these cooperation bridges is an efficient strategy for schools. It enables schools to focus their main energies on those non-transferrable aspects of education that are kept within their optimum area of expertise.

However, it cannot be denied that incorporating these new actors involves a major shift in the traditional composition and operating dynamics of the professional landscape. This could be seen as a break from the professional-institutional monopoly (Enguita, 2008). The fact is that, in the network society, it is more and more difficult to see the teacher as a solitary worker limited to the school itself (or even limited to the local community). The opportunities and what is facilitated by ICTs for collaboration with various individuals, groups and entities (not limited to the immediate surroundings) have made them a requirement and guarantee for implementing quality educational projects as a network. Schools thus have great potential as the hub for a broad education community and network. The notion of the teaching profession is at the heart of this transformation. Teachers are being called upon to be nodes in this network and take on a fundamental role in activating education projects that will explore context-related opportunities to link various actors and resources around a shared objective. It is a strategic capacity to adopt this position in order to efficiently respond to the complex and changing challenges of our society. In order to take on this role, teachers must have the working conditions conducive to a culture of collaboration and an alternative vision of the environment that seldom form part of a traditional view of the profession.

Conclusions and policy implications

Across the world, the aim of education systems is still to adequately prepare young people to become active, participatory citizens committed to the culture and improving the quality of life and economic development of their societies. It is an age-old challenge that requires new solutions because the situation has changed (and this brings with it new challenges for education). The knowledge society and the adoption of ICTs offer new opportunities to schools as a professional setting, in exchange for a review of the traditional parameters surrounding teaching and the competences needed to practice as a teacher. Effectively incorporating technologies (to ensure value added in terms of educational innovation) requires an in-depth transformation of the culture of schools and teachers. This is a complex process that cannot be expected to happen thanks to the mere presence of ICTs. It requires the involvement of the education community in its broadest sense and – particularly – the active participation of the teaching force. The emergence of technology has not relegated teachers to a secondary role. In fact, teachers have a special place reserved in the process for driving through change. However, teachers' actions are largely dependent on the conditions in which they must carry out their day-to-day duties.

Creating the right conditions for teachers to embrace ICTs in order to experiment with and design personalized learning environments and new network collaboration strategies involves transforming some of the structural components of education systems. However, having more flexible and open structures does not necessarily depend on education policies. The formation of the network society has required adaptation mechanisms linking all sectors of the economy and culture. The education sphere should be able to link its own components. These changes do not have to be introduced by governmental policies, but the latter do have an unavoidable responsibility to create a professional setting that facilitates innovation. This is a complex challenge that cannot easily be resolved by just adding technological resources onto the existing system without changing it and while maintaining the traditional composition and operational dynamic. School structures themselves would need to become less rigid and more open to the environment. The effectiveness of ICT policies in education is largely dependent on their capacity to contribute to a transformation on this scale. The aim is to help create a new concept of effective schools that can serve as a benchmark for young people in terms of the type of organization and form of professional activity suited to the parameters of education in the knowledge society. It therefore seems that education policies themselves need to change and give up the need to be in charge. Education policy should prioritize the promotion of conditions that would incentivize schools and their professionals (bolstered by autonomy) to collaborate on the design of networked education projects that can meet the needs of the specific setting while making use of the opportunities offered by that setting. The same policies that reinforce the decision-making capacity of teachers should ultimately also encourage professional reflection on these experiences and contribute to the generation and dissemination of the knowledge needed for innovation.

With this approach, any education policies focusing on the innovative use of ICTs in teaching should at least be implemented through the same axes along which these technologies have transformed the profession, namely:

ICTs policies for a new professional environment

A school's organizational structure should provide an enabling environment for a profession like teaching that is increasingly expected to develop dynamically in open spaces geared towards interdisciplinary collaboration and exchange. ICT policies should facilitate the adoption of these technologies when they are used to build such environments, and particularly when they are used for specific projects to connect various individuals around the same education objective by avoiding conventional restrictions of space, time and other barriers of conventional school structure.

Teaching activity is thus gradually connected by professional networks. ICT policies should contribute to the construction and efficiency of these networks as they move beyond mere communication and exchange to enable the school to function like a professional learning community. The aim is to provide support to projects that organizations can use to embrace technologies and identify and highlight their professional knowledge capital (with a view to reformulating and converting it into the organization's knowledge, before sharing it outside the school walls using the possibilities offered by the network).

ICT policies for new forms of teaching

Irrespective of the type of pedagogical practice involved, the policies that have prioritized ICT adoption in schools have mainly served to maintain a traditional teaching model that is now proving unable to respond to modern challenges. Despite high investment, the efficiency of these policies has been extremely low and their effects on educational improvement negligible. As an alternative to what is imposed by the administration, it is preferable to have other strategies that can promote and support teachers' initiatives for innovative projects. In these cases, ICTs are mainly used to resolve complex real-life situations using collaboration processes. Teachers must have the right working conditions for efficiently carrying out their role in guiding and supporting diverse learning trajectories in such projects, using personalized teaching methods. Promoting these conditions is undoubtedly one of the main challenges of education policy. It is about facilitating a professional space that develops teacher collaboration and initiative on such projects – which will ultimately help to identify and design the technological support needed to promote autonomous learning among students.

Some of the main factors contributing to the definition of a professional space are the design of curricula and assessment processes. Education policies can play a major role in both regards. In terms of the curriculum, education policies can help shift teachers' attention onto the type of competences required in the twenty-first century (and towards teaching methods that can facilitate the learning of these complex skills relating to collaboration, creativity and self-management). In addition, policies can also promote more complex assessment models geared precisely towards the learning of these competences and the ability to identify everything that a student has learned as a result of active participation in a crosscutting learning project. These are the circumstances that would enable teachers to see ICTs as a powerful ally for teaching that can be mainstreamed into the curriculum to provide valuable tools for new forms of assessment.

ICT policies for professional networking activity

Generally speaking, education policies have seen effectiveness as a result of the dynamics produced within schools, and more specifically as the outcome of the actions of their professionals. In the network society, however, the most valuable educational experiences are less and less dependent on the work of schools and each teacher, and increasingly dependent on networking with the community (in its broadest sense, rather than just actors from the immediate

environment). In this regard, policies must include shared educational responsibility for networked education projects as a quality criterion. With this in mind, these policies need to offer ways of supporting the design of such projects and, more specifically, the means of facilitating the coordination and shared management among schools, administration and other relevant entities and actors.

The aim is to help teachers move towards networking as a professional setting that can bring together diverse organizations and actors to work together on specific education projects. It is impossible to ignore the major challenge facing teachers in terms of opening up their professional sphere (particularly when we consider that teachers remain a mobilizing agent in such projects). These network dynamics can be activated by any actor, and their functioning is therefore closely linked to the initiative of participating professionals, their decision-making tools, the capacity to respond and adapt to the changes associated with these projects and – ultimately – to the methods and strategies that facilitate the involvement and commitment of all those concerned. Herein lies the importance of support policies that can promote shared responsibility among the various actors and provide teachers with more favourable working conditions. This would ultimately encourage teachers to view an openness to the outside world as a source of opportunities and a learning space that – through interprofessional collaboration – can generate valuable knowledge for school organization as a whole.

Making ICTs into an effective instrument for educational improvement has not proved to be a simple or automatic process resulting from placing technologies in the hands of teachers. The difficulty lies in how complex it is for schools to embrace these technologies with a broad vision of what they can provide to innovation (in terms of the main axes of how their activity is linked to a network society in a globalized world). This very complexity points to why the impact of ICTs in swaths of our society has been so limited in transforming the teaching profession. The effect that ICTs can have on teachers' daily activities is inextricably linked to the need to build a professional space that is more suited to the parameters of modern education (and therefore more flexible or open to networking and to providing more opportunities for teachers' creativity and initiative). This development is largely dependent on schools being seen as organizations that can respond to 21st-century challenges and become a reference point for young people. Ultimately, this is also dependent on the teaching force becoming an attractive profession that can rise to the challenges of education in a knowledge society.

References

- Bauman, Z. (2003) "Educational Challenges of the Liquid-Modern Era", *Diogenes* 50: 15–26.
- Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecologies perspective. *Human Development*, 49, 193-224.
- Carnoy, M. (2002) *Sustaining the New Economy. Work, Family and Community in the Information Age*. New Cork: Russell Sage Foundation/Harvard University Press.
- Castells, M. (2000) *The rise of the Network Society*. Malden (MA), Blackwell Publishers.
- Castells, M. (1999) *La era de la información. Economía, Sociedad y Cultura* [The information age: economy, society and culture]. Barcelona: Alianza Editorial.
- Coll, C. (2013a), El currículo escolar en el marco de la nueva ecología del aprendizaje. [The school curriculum in the framework of a new learning ecology]. *Aula de innovación educativa* [Educational innovation classroom], 219 31-36.
http://www.psyed.edu.es/prodGrintie/articulos/Coll_CurriculumEscolarNuevaEcologia.pdf
- Coll, C. (2013b) "La educación formal en la nueva ecología del aprendizaje: tendencias, retos y agenda de investigación" [Formal education in the new learning ecology: trends, challenges and research agenda]. J.L. Rodríguez Illera (Comp.) *Aprendizaje y educación en la sociedad digital* [Learning and education in the digital society]. Barcelona: Universitat de Barcelona.
http://www.ub.edu/seasd/wp-content/uploads/2013/11/ApyEd-en-la-sociedad-digital_completo.pdf
- Cuban, L. (2012) *Dilemes polítics i docents de l'ús de les TIC a l'aula. El cas dels Estats Units* [Policy and teaching dilemmas in the use of ICTs in the classroom. The case of the United States]. Barcelona: Fundació Jaume Bofill.
<http://www.debats.cat/sites/default/files/debats/pdf/dilemes-politics-docents.pdf>
- Cuban, L. (2001) *Oversold and Underused. Computers in the classroom*. Cambridge (MA): Harvard University Press.
- Cuban, L.; Kirkpatrick, H. & Peck, C. (2001), "High access and low use of technologies in high school classrooms: explaining an apparent paradox", *American Educational Research Journal*, 38 (4), pp. 813-834.
- Cuban, L. (1986) *Teachers and machines. The classroom use of technology since 1920*. New York: Teachers College Press.
- Dale, R. (2005) "Globalisation, knowledge economy and comparative education". *Comparative Education*, 41, 2, pp.117-49.
- Davidson, C. N. & Goldberg, D. T. (2010). *The future of thinking. Learning institutions in a digital age*. Cambridge, Massachusetts: The MIT Press.
<https://mitpress.mit.edu/books/future-thinking>
- Davidson, C. N. & Goldberg, D. T. (2009). *The future of learning. Institutions in a digital age*. Cambridge, Massachusetts: The MIT Press.
<https://mitpress.mit.edu/books/future-learning-institutions-digital-age>
- DuFour, R.; Dufour, R.; Eaker, R. and Many, T. (2006) *Learning by Doing: A Handbook for Professional Learning Communities at Work*. Bloomington, IN: Solution Tree Publishers.

- Dumont, H. Istance, D. and Benavides, F. (2010) *The Nature of Learning. Using research to inspire practice*. Paris: OECD.
- Enguita M. F. (2008) “Centros, redes i proyectos” [Centres, networks and projects], M.F. Enguita, E. Terrén (cords.) *Repensando la organización escolar. Crisis de legitimidad y nuevos desarrollos* [Rethinking school organization. Legitimacy crisis and new developments]. Madrid: Akal
- European Commission (2010) *New Skills for New Jobs: Action Now*. Brussels, European Commission.
- Florida, R. (2004) *The Rise of The Creative Class*. New York: Perseus Books Group.
- 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.
- Gordó, G. (2010) *Centros educativos: ¿islas o nodos? Los centros como organizaciones-red* [Schools: islands or nodes? – Schools as network organizations]. Barcelona: Graó.
- Hargreaves, A. (2003) *Teaching in the Knowledge Society: Education in the Age of Insecurity*. New York: Teachers College Press.
- Hargreaves, A. (2000) “Four Ages of Professionalism and Professional Learning”, *Teachers and Teaching: History and Practice*, 6, 2, 151-82.
- Hargreaves, D. (2001) *Creative professionalism. The role of teachers in the knowledge society*. London: Demos.
http://www.bucksgfl.org.uk/pluginfile.php/2366/mod_resource/content/0/creativeprofessionalism.pdf
- Hargreaves, D. (2003b) *Transforming secondary schools through innovation networks*. London: Demos.
http://books.google.es/books?id=XdnS6nGXQWcC&printsec=frontcover&hl=ca&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
- International Society for Technology in Education [ISTE] (2007), *National Educational Technology Standards and Performance Indicators for Students*. Eugene, OR: ISTE.
- Istance, D. (2006) “Los escenarios de la escuela de la OCDE, el profesorado y el papel de las tecnologías de la información y la comunicación” [OECD school scenarios, teachers and the role of information and communications technologies]. In J.M. Sancho (Coord.) *Tecnologías para transformar la educación* [Technologies to transform education]. Madrid: Ediciones Akal.
- Kozma, R. B. (2012) *Les TIC i la transformació de l'educació en l'economia del coneixement* [ICTs and the transformation of education in the knowledge economy]. Barcelona: Fundació Jaume Bofill
<http://www.debats.cat/sites/default/files/debats/pdf/kozma.pdf>
- Kozma, R. B. (2011) “The technological, economic, and social contexts for educational ICT policy” in R. B. Kozma, (ed.), *Transforming Education: The Power of ICT Policies*. Paris: UNESCO, pp. 3-18.

- Kozma, R. B. (2009) "Assessing and teaching 21st century skills: A call to action", Sheuerman, F. i Bjornsson, J. (eds.), *The transition to computer-based assessment: New approaches to skills assessment and large-scale testing* (pp. 13-23). Brussels, European Communities.
- MacBeath, J. (2012). *Future of teaching profession*. Educational International Research Institute and University of Cambridge.
- Martín-Moreno, Q. (2010) *Organización y dirección de centros educativos innovadores. El centro educativo versátil*. [Organization and management of innovative schools. The versatile school]. Madrid: McGraw-Hill
- OECD (2012), *Better Skills, Better Jobs, Better Lives: A Strategic Approach to Skills Policies*, OECD Publishing. <http://dx.doi.org/10.1787/9789264177338-en>
- OECD (2011), *Students on line: Reading and Using Digital Information*, OECD Publishing.
- OECD (2010), *Are the New Millennium Learners Making the Grade?: Technology Use and Educational Performance in PISA 2006*. Paris: Educational Research and Innovation, OECD Publishing.
- OECD (2009a), "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 (2009b) *Working Out Change: Systemic Innovation in Vocational Education and Training*. Paris: OECD Publishing.
- OECD (2006), *Are Students Ready for a Technology-Rich World? What PISA Studies Tell Us*", OECD Publishing.
- OECD (2003) *Networks of Innovation. Towards New Models for Managing Schools and Systems*. Paris: OECD Publishing.
- Partnership for 21st Century Skills (2005), *A Report on the Landscape of 21st Century Assessment*. Washington, DC: Partnership for 21st Century Skills.
- Partnership for 21st Century Skills (2003), *Learning for the 21st century*. Washington, DC: Partnership for 21st Century Skills.
- Pedró, F. (2011), *Tecnología y escuela: lo que funciona y por qué* [Technology and school: what works and why]. XXVI Semana Monográfica de la Educación: La educación en la sociedad digital [26th Education Week: education in the digital society]. Madrid: Fundación Santillana.
- Pedró, F. (2006), *The New Millennium Learners: Challenging our Views on ICT and Learning*. Paris: OECD – CERI.
- Pelgrum, W.J. (2001), "Obstacles to the Integration of ICT in education: results from a worldwide educational assessment", *Computers and Education* 37, pp. 163-187.
- Sammons, P.; Hillman, J. and Mortimore, P. (1995) *Key Characteristics of Effective Schools*. London: University of London. Institute of Education/Office for Standards in Education.
- Sancho, J. (1996), "Software educativo. Los límites duros de una tecnología blanda" [Educational software: the hard limits of soft technology], *IV Jornadas de Software educativa* [4th Education software conference], Granada, Centro de profesores de Granada, pp. 53-70.

- Santos, M.A. (2010) “La formación del profesorado en las instituciones que aprenden” [Teacher training in learning institutions], *Revista Interuniversitaria de Formación del Profesorado*, 68 (24,2), 175-200.
- Senge, P. (2006) *The Fifth Discipline. The Art and Practice of the Learning Organization*. New York: Currency Doubleday.
- Senge, P., Cambron-McCabe, N., Lucas, T., Smith, B., Dutton, J. and Kleiner, A. (2000). *Schools that Learn: A Fifth Discipline Fieldbook for Educators, Parents, and Everyone who Cares about Education*. New York: Doubleday.
- Sharples, M., McAndrew, P., Weller, M., Ferguson, R., Fitzgerald, E., Hirst, T., Mor, Y., Gaved, M. & Whitelock, D. (2012). *Innovating Pedagogy. Exploring new forms of teaching, learning and assessment, to guide educators and policy makers*. Open University. Innovation Report 1. http://www.open.ac.uk/personalpages/mike.sharples/Reports/Innovating_Pedagogy_report_July_2012.pdf
- Schrum, L. and Levin, B. (2009) *Leading 21st Century Schools: Harnessing Technology for Engagement and Achievement*. Thousand Oaks, CA: Corwin.
- Schleicher, A. (2011), *Building a High-Quality Teaching Profession: Lessons from around the World*, OECD Publishing. <http://dx.doi.org/10.1787/9789264113046-en>
- Trilling, B. and Fadel, C. (2009), *21st Century Skills: Learning for Life in our Times*. San Francisco: Jossey-Bass.
- Trucano, M. (2005). ICT components in World Bank education projects (2001-04). Washington, DC: infoDev/World Bank.
- Tyack, D. and Tobin, W. (1994) “The Grammar of Schooling: Why Has It Been So Hard to Change?” *American Educational Research Journal* 31/3: 453-80.
- UNESCO (2008a), *Medium-Term Strategy for 2008-2013*, Paris: UNESCO.
- UNESCO (2008b), *ICT Competency Standards for Teachers: Policy Framework*. Paris: UNESCO.
- UNESCO (2002). *Information and Communication Technology in Education: A Curriculum for Schools and a Programme of Teacher Development*. Paris, UNESCO.
- UNESCO (1996), *Report to UNESCO of the International Commission on Education for the Twenty-first Century. Learning: The Treasure Within*. Paris: UNESCO.
- Williamson, B. (2013). *The future of the Curriculum. School knowledge in the digital age*. Cambridge, Massachusetts: The MIT Press. <http://mitpress.mit.edu/books/future-curriculum>
- Zhao, Y. (2012), *World Class Learners: Educating Creative and Entrepreneurial Students*. California: Corwin Press.