Future Learning 3

Pedagogic Innovations with the use of ICTS

From wider visions and policy reforms to school culture

Andreas Kollias
and Kathy Kikis

UNIVERSITAT DE BARCELONA

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List of abbreviations

ACOT:	Apple Classroom of Tomorrow.
ATPs:	Approved Training Providers, UK.
BECTa:	British Educational Communications and Technology Agency.
CDK:	Microsoft's "Curriculum Delivery Kit".
CLCs:	City Learning Centres, England.
DfES:	Department for Education and Skills, UK.
eLCs:	electronic Learning Credits.
eLIG:	eLearning Industry Group.
ERT:	The European Round Table of Industrialists.
EU:	European Union.
GATS:	General Agreement on Trade in Services.
HMCI:	Her Majesty's Chief Inspector of Schools, UK.
IACM/FORTH:	Institute of Applied and Computational Mathematics/Foundation for Research and Technology-Hellas.
IAWs:	Interactive Whiteboards.
ICTiS:	"ICT in schools" programme (2003-2006), England.
ICTs:	Information and Communication Technologies.
ITMF:	"IT medier & folkeskolen" -IT, media and primary and lower secondary school programme (2001-2003), Denmark.
KERIS:	Korea Education and Research Information Service.
LEA:	Local Education Authority, UK.
LoTi:	Levels of Technology Implementation.
NCET:	National Council for Educational Technology, UK.
NGfL:	National Grid for Learning (1998-2002), UK.
NOF:	New Opportunities Fund, UK.
OCenW:	Ministerie van Onderwijs Cultuur en Wetenschappen - Ministry of Education, Culture and Science of the Netherlands.
OECD:	Organisation for Economic Cooperation and Development.
Ofsted:	Office for Standards in Education, UK.
PITAC:	President's Information Technology Advisory Committee, USA.
PPPs:	Public Private Partnerships.
RBCs:	Regional Broadband Consortia, UK.
R & D:	Research and Development.
SIBIS:	Statistical Indicators: Benchmarking for the Information Society.
SITES:	Second Information Technology in Education Study.
SYPREDEM:	Synergy between Practitioners' needs and opportunities, Research orientations and Decision Making on the use of ICT in primary and secondary education.
TTA:	Teacher Training Agency, UK.
UNESCO:	United Nations Educational, Scientific and Cultural Organization.
UNIC:	Danish IT Centre for Education and Research.
WTO:	World Trade Organisation.

Preface, or on the outstanding matter of research on educational innovation

In theory, the aim of a preface should be to introduce the relevance of a work by highlighting its most significant points. In this case, dealing as we are with an excellent academic work, I will limit myself to a mere *laudatio*, doubtless merited, but which may lead you to think that it is rhetorical. I know the authors of the work very well –they are people with whom I have shared research projects, hopes and disappointments– to resist the temptation, in these paragraphs, to strike up with them an academic debate which may entice the reader to continue reading with passion both this work and those that I am sure will continue to be published in the future.

What this work has to offer

To begin with, I believe that this work perfectly maintains the contemporary standards of social research, something that is not as frequent as one would hope in the field of education. In fact, it seeks to respond to a perfectly defined question and one which, in essence, is related to the reasons why it is so difficult for educational innovation based on an intensive use of technology to be realised in schools. It attempts, therefore, to identify those factors and conditions that may help us better understand the processes related to the emergence and diffusion of educational innovations in schools. In order to respond to this question, the work makes use of research done on various projects where the authors' participation has been vital. In this way, using the evidence found in various projects which, on the whole, are characterised as being action-research projects or projects for developing innovations, this is an attempt to contribute to the construction of a theoretical framework which is suitable for the development of subsequent empirical research and research-supported policy making.

For readers unfamiliar with the world of educational technologies, the existence of this theoretical framework may appear redundant or, even worse, unnecessary. It cannot be redundant in any way, shape or form, as there are hardly any works which, not only in terms of reflection but in terms of empirical evidence, establish a theoretical framework which allows the development of our hypothesis regarding why innovations are developed or not, given certain circumstances, when technology comes into play in the school environment. It may seem strange, but such a framework does not exist despite the availability of numerous practical works on the market where individual authors offer their personal perspective on the matter.

Secondly, this is a much-needed contribution because without it, and without others that sooner or later will follow, it would be impossible to deepen our understanding of pedagogic innovation with the use of ICTs in education. We need a theoretical framework –even one that includes the inevitable lagoons and inconsistencies that make it permanently provisional– sufficiently thought-provoking to once more ask ourselves questions which will lead us to respond through social research based on empirical evidence. Unfortunately, in many European countries, the field of education appears to have rejected the contributions of empirical research, probably due to ideological reasons that identify a certain positivism, which –not without cause– may be considered arrogant and outdated, with a lack of respect for the more personal, relational or emotional components present in any educational process. Nevertheless, it is difficult to imagine this empirical perspective of social research being dispensed with. Can decisions be taken regarding, for example,

the educational policies to be followed on both a national and institutional scale by the rejection of their contributions? It is true that there may exist equally valuable sources, such as ethnographical research, which are not based on the criteria of empiricism and, at least in terms of social phenomena characterised by an enormous complexity, as is the case with education, common sense dictates that no reliable source of contrasted and contrastable information should be rejected. Clearly, this is a debate that can go on forever, but the important thing to point out here is that a work such as this is essential in establishing good empirical research.

Why it is relevant to empirical research

I am sure that this work will have a fundamental effect on later research, in the sense that other works that contribute to the improvement of the initial theoretical framework may base themselves on this one. What you will find on the following pages is clearly established in terms of evidence and is sufficiently solid for the researchers who carried out the work to submit new hypotheses for improving our understanding and our capacity to act on the improvement of quality of teaching and learning processes through the incentive of innovation.
To my mind, viewed in this way one of the main conclusions we can draw is that both the emergence and the diffusion of innovation depend on factors and conditions which actually have little or nothing to do with technology itself or the countless pedagogical possibilities they offer. Some of the factors presented as critical in this work are related to wider socio-economic visions and actual policies which affect how school performs their functions, the unique school cultures where the teaching staff perform their duties, their capacity to respond autonomously to the educational requirements and needs of the members of the school communities, leadership, and “style” of innovation.

Three questions...

It is within precisely this context that I have allowed myself to carry out a small exercise aimed at suggesting to the reader why this theoretical framework is thoroughly relevant to research and to what extent it suggests the importance of empirical research. I am going to do this, firstly, using one of the main assertions of this theoretical framework. Secondly, I am also going to use a critical element that hardly appears in this theoretical framework and which, to my mind, is one of the keys we should take into account; and, thirdly, I would like to introduce a question that we probably still do not have enough data to answer.
The three questions are as follows:

1. As suggested in this work, essential factors for the production of educational innovations focused on the use of technologies are: the training of teaching staff, the level of autonomy of schools and a political framework which promotes innovation. Can we verify this assertion using empirical data?
2. I believe, however, that the reference to the environment of both the students and the school is essential for understanding the emergence of innovations focused on the use of technologies. That is to say, that only if in students’ homes and in those of their teachers technology plays a vital role or is present in daily operations in the social, cultural and economic environment in which they live, only then can the remaining factors outlined above produce the resulting emergence and diffusion of innovations. To what extent, then, is this environment crucial?
3. The most relevant aspect to be decided is, though, not which factors explain the emergence and diffusion of pedagogical innovations, but to what extent these innovations, and the conditions which make them possible, translate into substantial improvements in educational results. Can we really demonstrate that there is a significant relationship between the use of technology in teaching and an improvement in academic results?

Demonstrating or refuting any of these three assertions with the use of empirical data is not easy, firstly, due to the lack of data and time periods of sufficient length. For this reason, and also because an exploratory work which goes into excessive detail would not make sense, being as it is a mere preface, I shall only present a few elements, fragmented and incomplete,

to suggest to what extent a greater dose of empirical research is necessary and urgent; and, as is my custom, I shall adopt a comparative perspective based on the data we have available on the countries which make up the European Community.

How many factors explain educational innovation: three, or only two?

Let us begin with the first question regarding factors considered essential for the emergence of educational innovation through an intensive use of technology. In accordance with that presented in this work, three of the more essential factors would be the training of teaching staff, the pedagogical autonomy of schools and a suitable political framework for promoting the use of technology. At the risk of committing errors of appreciation as this exercise is merely exploratory, I propose we put these factors into operation by focusing our attention on primary education. The training of teaching staff could be equal to the percentage of teachers who have received some type of training in terms of technology[1]. To put the level of pedagogical autonomy of schools into perspective, we could use previous works that have attempted to quantify this[2]. In order to have an idea of the political pressure that is exercised on educational innovation based on technology we can take the data concerning the availability of computers in schools[3], assuming that this is a genuine expression of the political emphasis in this field. However, the real problem appears when we try to assign values to the level of educational innovation based on technology for each country. Once more, as this is an exploratory work, I shall consider that an indirect indicator of this innovation can be obtained by combining the weekly use of technology in the classroom together with the percentage of teachers who use it regularly, for which I have created an extremely simplified index[4], which we shall call the index for the use of technology in teaching.

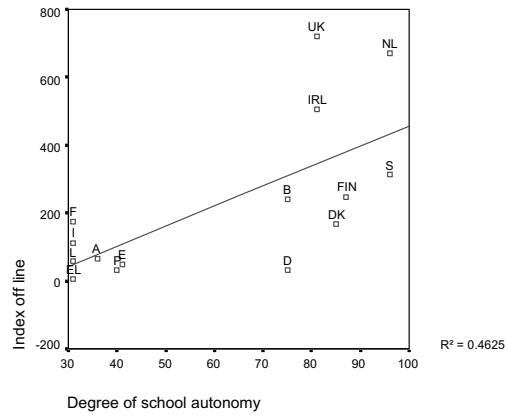

Figure 1. Graphical representation of the relationship between school use of off–line technology and degree of school autonomy.

Results show that an extremely significant relationship exists between two of these variables and the index for the use of technology in teaching, both *on–line* and *off–line*: the level of schools' pedagogical autonomy ($p < 0.005$) and to a lesser extent the level of training teaching staff in the use of technology in the classroom ($p < 0.01$). In contrast, there is no significant relationship between the availability of technology, expressed in the ratio of students to computers, and the index for the use of technology in teaching. A more detailed examination of this question reveals that the relationship tends to be significant but that there are three cases (Ireland, the Netherlands and the United Kingdom) where with the same availability of technology in classrooms as in other countries they achieve much higher indices of use[5]. These three cases signify that the

1. Data taken from the Eurobarometer Flash 101 and Flash 102 of February/May 2001.

2. Autonomy is understood here to mean the level of freedom the school has to take independent decisions in one or all of the following fields: pedagogy, staffing and finance management. Data taken from the OCDE and the Eurydice and which probably require a detailed review.

3. Also taken from Eurobarometer Flash 101 and Flash 102 of February/May 2001.

4. Once more, with data taken from Eurobarometer Flash 101 and Flash 102 of February/May 2001, the index was constructed by multiplying the percentage of teachers who claim to use technology by the average number of hours' use per week. Logically, countries with high values in both variables obtain a much higher result than those with low values in both cases. In fact, two different indicators are obtained: one for *on–line* use and one for *off–line* use, much more frequent and widespread.

5. If, however, instead of using the index we have created we cross-reference the data regarding the availability of technology with the percentage of teachers who use it on the one hand, and number of hours' use per week on the other, the results are significant, although

relationship between use in the classroom and the availability of technology is not a significant one.

Therefore, in an attempt to respond to the first question, we may conclude that the use of technology in the classroom, and consequently the probability that innovations will emerge, depends much more on schools' level of autonomy and the levels of training of the teaching staff in this use than the availability of the technology itself. The relationship between these variables is so intense that it may even establish a regressive equation that allows us to explain up to 56% of the variance between European countries in the *off–line* use of computers in the classroom and 51% in *on–line* use. We are, consequently, a long way from explaining this variance, but we are probably faced with two of the main explicative factors, as shown in figures 1 and 2 for school autonomy and the training of teaching staff, respectively. This does not mean that political pressure is not relevant, but that, with the data we have available[6], we have not been able to demonstrate a significant relationship.

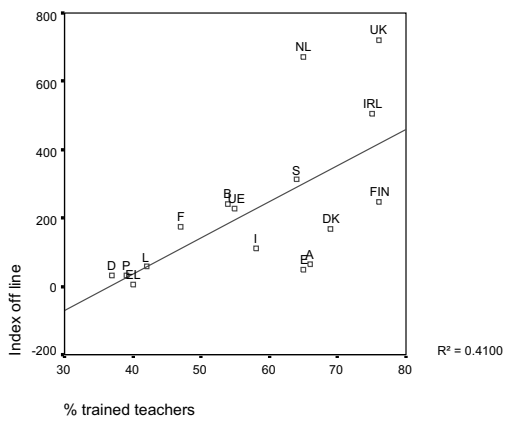

Figure 2. Graphical representation of the relationship between school use of off–line technology and percentage of teachers trained in the uses of technology.

Does what happens outside school count for anything?

The second question we posed refers to the explicative capacity of the environment surrounding the school and, if formulated in hypothetical terms, it would affirm that the use of technology in the classroom is very much related to the level of use of these technologies outside schools, which is to say, in the other domains of social, economic and political life. In order to define the level of usage produced outside the school environment I have opted to use an index which is defined as the level of daily use of technology by individuals, business and public administrations[7]

The results obtained in this case do not give such a clear picture at first sight, but they are perfectly consistent with the initial supposition. If we cross-reference the values on daily use outside school with the percentages of teachers who use it at school, the result is extremely significant given that it demonstrates a significant relationship between both uses, more intense in *off–line* use than in *on–line* use ($p < 0.001$ and $p < 0.01$, respectively), as shown by figure 3 regarding *off–line* use.

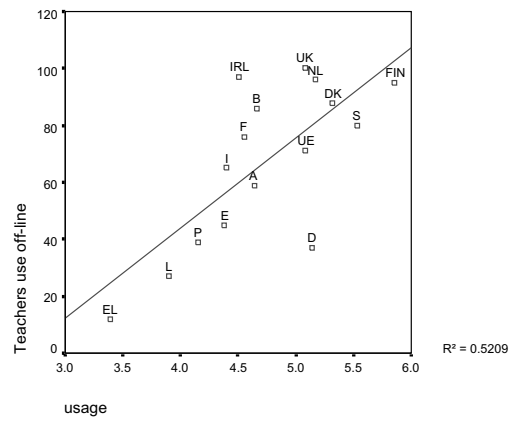

Figure 3. Graphical representation of the relationship between school use of off–line technology and index of out-of-school use of technology by individuals, business and public administrations.

not with the same intensity as that revealed by the other two factors in the index.

6. And in the way we have put this pressure into operation, which is completely debatable.

7. The index was created by INSEAD for the report *The Networked Readiness of Nations* at the World Economic Forum (2003)..

Nevertheless, when the same is done not with the percentage of teachers-users but with the number of hours of weekly use in the classroom, the result is no longer significant. Undoubtedly, a plausible explanation is that a favourable out-of-school environment increases the probability of converting teachers into daily users outside and inside the school, but this does not necessarily mean that pedagogical use –which is better reflected in the volume of weekly hours of use in the classroom– is greater, because this is affected by other factors such as the importance given to technology in different subjects and pedagogical projects –which requires a high dosage of pedagogical autonomy for the school– and the suitable training of teaching staff on the pedagogical use of technologies.

The verification of this hypothesis is expressed in the fact that if we now try to explain the different level of use of technology in teaching –referring to the index we have created– as regards three factors –school autonomy, the training of teaching staff and the level of out-of-school use of technology– the resulting regression explains up to 63% of the variance in *off–line* use and up to 59% of *on–line* use, values which are slightly higher than those we had obtained until now (56% and 51%, respectively). In conclusion, one highly determining factor is out-of-school use of technology by individuals, business and public administrations.

But after all of this, are we achieving better results?

We are still left with the final and most important question about the relationship between teaching innovation and school results. Without wishing to introduce easy reductionisms, but with the aim of benefiting from what little comparative evidence there is, I have used the results for mathematics, science and reading for 15-year-olds obtained from the PISA project (2000), promoted by the OCDE, as an indicator for school results and have attempted to establish whether or not there exists a correlation between school results expressed in this way and the index for the use of technology in teaching.

The results obtained are significant in all cases, with only one exception: the correlation between results in mathematics and the index of *on-line* teaching use. In all other cases there is a significant relationship, tenuous but at an acceptable level ($p < 0.05$), which is an indicator that the use of technology in the classroom is probably not an explicative factor with a direct effect on school results, it rather contributes with other factors and, at the same time, is an expression of them. In any case, it is clear that countries that obtain better results are countries where, generally, there is an intensive use of technology in the classroom. Figure 4 offers, by way of example, a graphic representation of the correlation between results in reading and the use of *off–line* technology in the classroom.

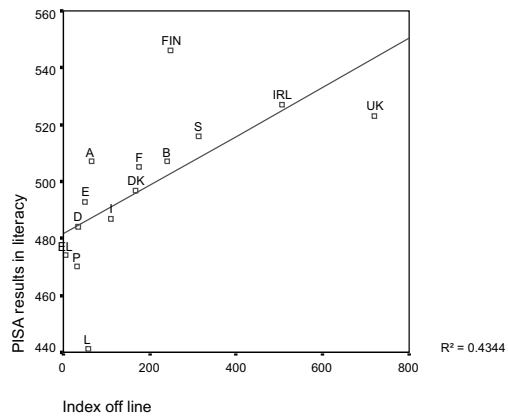

Figure 4. Graphical representation of the relationship between school use of off–line technology and PISA Project results on literacy.

What is still to be done?

There is still much work to be done in terms of empirical research on education. The sample I have presented here, almost like a game, I believe to be the true expression of how our political and pedagogical debates can benefit greatly from empirical evidence. Unfortunately, I have limited myself to comparative evidence and there is still much to be done in terms of evidence regarding results inside the classroom. I would like to conclude by returning to my starting point and highlighting once more the importance of the pages that follow, whilst asking for the reader's benevolence when judging that which he has just read. He has in his hands an excellent

springboard for research and I believe that our academic field will benefit enormously from the theses contained in this work, as they outline an absolutely essential theoretical framework, albeit a provisional one. And, just as everything else in life, we also should apply to theoretical frameworks the classic aphorism *panta rei*. The passion of researchers consists, precisely, in asking ourselves on a daily basis if that what we believed to be true has been challenged or superseded. That very passion is present in this work and in its authors and I hope that it infects the reader.

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Introduction

The overall purpose of this work is to contribute to the strengthening of links, collaboration and the development of shared understanding and action among teachers, researchers, administrators and policy makers in the design, implementation and diffusion of pedagogic innovations with the use of new information and communication technologies (ICTs). Its specific aim is to build a framework for identifying and understanding crucial factors, conditions and processes inherent in the emergence, sustenance, diffusion and adoption of ICTs-related pedagogic innovations in schools.

The ideas that will be discussed in this book emerged during our involvement in a number of research and development (R&D) projects on ICTs-related innovations in the field of education and training and our collaboration with research institutes, universities, schools, teachers and pupils from several EU countries. What motivated us most to elaborate on these ideas was our concern about what happens after an R&D project in schools has been formally completed. Will the involved schools, teachers and pupils continue and extend the ICTs-related innovative practices developed during the project? Will other schools, local and regional school administrators get to know them and, more importantly, will they integrate them in their own school development plans? How the outcomes of ICTs-related innovations can inform decision making regarding the integration of ICTs in schools? Such concerns, was not difficult to discover, were shared among researchers and long standing partners in European projects, as well as, teachers and local school administrators with whom we had the chance to collaborate with. What more, there was a shared feeling among researchers and teachers alike that no matter how promising the outcomes of a particular research might be and despite the hard work and dedication of the people involved, ICTs-related innovations implemented during R&D projects have little chances of being sustained let alone diffused at local, regional and national level.

Not a few people would find it justified to respond to the above by blaming schools and the teaching workforce for inertia and school education as a bureaucratic and aged institution which is slow to follow the advances in the fields of technology and social science or the breathtaking changes that take place in the wider society and especially in economy and work. It is, for example, quite widespread the belief that despite the theoretical and research efforts accumulated over the last two decades which strongly suggest that constructivist and socio-cultural approaches to learning are much more powerful than behaviouristic models in explaining how people learn, create meaning and understand, school education appears largely to rely on frontal teaching and rote learning. Similarly, despite intensive policy making efforts and the implementation of huge funding schemes aimed to equip schools with ICTs and provide teacher training, regular use of ICTs for school teaching and learning is often limited to a small sub-set of its educational potentials and, quite understandably, has not as yet provided us with clear evidence that all this have actually improved the quality of education. Being rather unconvinced that this is the whole picture we decided to take another, hopefully more constructive, route, trying to identify and investigate factors, conditions and processes that may play a potentially crucial role in the conductivity (or, apparently, the lack of conductivity) of schools to ICTs-related pedagogic innovations.

Andreas Kollias & Kathy Kikis

Heraklion, July 2004

Pedagogic innovations with the use of ICTs in schools

Frade (1998, pp.43-4), reviewing several innovation case studies in education and training in many European Union countries arrived at the conclusion that, during the last decade, the most important innovations have taken the forms of *a*) sector/domain specific *partnerships and networks* between educational institutions, public bodies and industry, *b*) new *organisational models* in education or training institutions, *c*) utilisation of ICTs for teaching and learning, and *d*) implementation of new teaching/learning approaches. All of these forms of innovation in education and training were either enabled or supported by the development of new information and communication technologies (ICTs). Nevertheless, there seems to be a growing concern over the actual impact of ICTs on education and training, especially when this is compared to the impact of ICTs on other fields such as economy, work and leisure. According to Frade (1998), "the area that clearly appears as lagging behind is the very core of pedagogy, i.e. the teaching-learning process itself, as innovation efforts have not been very successful in bringing about new teaching-learning methods and functions matching the possibilities of ICT" (p. 47). Similar concerns were expressed in both sides of the Atlantic. In the USA for example, according to a report prepared by the *Panel on Transforming Learning* for the *President's Information Technology Advisory Committee*, "information technology accomplishments in education and training lag those in other areas, whether in research, commerce, or communications. It is hard to find another application area of information technology where the promise-to-performance gap is wider, and some assert the gap is widening" (PITAC, 2001, p. 5). In another report prepared by *The Web-Based Education Commission* for the President and the Congress of the United States it is argued that "schools often use technology to mimic this pattern of a top-down, lecture or text-driven model of instruction. Similarly, we have used the Internet in a narrow fashion, like vast textbooks or lectures online, instead of exploring its interactive potential" (The Web-Based Education Commission, 2000, p. 59). Evaluation reports on the actual use of ICTs for teaching and learning in schools in United Kingdom and the Netherlands, two countries with a long tradition in the implementation of ICTs-related educational policies, express similar concerns. According to a preliminary evaluation report on the NGfL Programme, the largest and most costly single initiative ever to be undertaken by local authorities in the UK, teachers often focus on basic rather than higher-order thinking and reasoning skills (ImpaCT2, 2001, p. 14). Another preliminary report revealed that innovative ways of integrating ICTs are rare among teachers (Somekh *et al*., 2001, p. 15). Similarly, government reports from the Netherlands admit that schools find it difficult to actually integrate ICTs into the teaching process (OCenW, 2000, p. 13), while the didactically innovative use of ICTs is still in its infancy (OCenW, 2001, p. 5). In another research funded by the European Commission (Smeets and Mooij, 2001), classroom observations in 25 technology rich primary and secondary schools in five European countries revealed that "... the use of behaviourist drill and practice exercises, approaches in which pupils are expected to follow exact instructions or approaches that leave pupils without instruction as to what is expected from them" (p. 415), was common in most of the lessons observed. As the researchers pointed out, "only a minority of 90 lessons that were observed were considered to be innovative lessons in which ICT use was integrated in pupil-centred learning environments" (ibid.)

The identification and discussion of important reasons why it is apparently so difficult to innovate using ICTs in school teaching and learning is a task that requires something more than compiling a list of "factors" which enable or hinder innovations in schools. The production of such

a list implies a "point of view" which often goes unnoticed although it very well may be part of the whole problem of how pedagogic innovations with the use of ICTs are conceptualised, implemented and diffused in schools. Before going to the issue of "factors" it is therefore important to develop a conceptual framework, an explicit point of view, a task that is further necessitated by the great, often misleading, vagueness with which educationalists, practitioners, software designers, policy makers, administrators and researchers talk about pedagogic innovations with the use of ICTs in schools.

1.1. School innovations: from perceived newness to effective integration

Perhaps the most widely adopted definition of innovation was offered by Rogers who suggested that an innovation is an "idea, practice or object perceived as new by a unit of adoption" (1995, p. 11). From a wider perspective, pedagogic innovations with the use of ICTs are geared by the:

- development of new ICTs products and services,
- development of new or refinement of existing educational/pedagogic theories,
- development of new scientific knowledge on teaching and learning, and the
- variety of ways that new and existing theories, knowledge and ICTs inventions can be combined and implemented on teaching and learning.

From a wider perspective, one can understand technology, theory, research, policy and practice as interrelated but autonomous forces that contribute to the emergence of innovations. However, the breathtaking technological advances that took place during the last two decades acted as a catalyst towards the development of pedagogic theories, research, and policies on teaching and learning focused around the potentials of technology to support collaborative learning, self-directed learning, lifelong learning, and learning from a distance. Pedagogues, researchers, practitioners and policy makers in the field of education commonly find themselves in the position to struggle to cope with the pace with which information and communication technologies advance and it is often not the emergence of new pedagogic theories and knowledge but the invention of new technologies that bring this aura of newness to the field of education and training.

A wide range of technological innovations which can be used for pedagogic purposes were, and still are, widely "new" to primary and secondary schools all over Europe. Discussing, however, the concept of *pedagogic* innovations with the use of ICTs in schools it is quite useful to go further than the perceived or actual *newness* of an ICTs-related teaching/learning theory, knowledge or product (for example the perceived newness of a theory on how ICTs should be used in teaching/learning processes, or of a software product that is designed on the basis of such a theory), to focus on the process of *integration* of an ICTs-related pedagogical theory, scientific knowledge and/or an ICTs product in the actual school teaching/learning activities, and the *outcomes* of such an integration. This is because what distinguishes an ICTs invention, a new pedagogic model or new scientific knowledge from a school-specific pedagogic innovation is the actual *integration* of the former into a teaching/learning school activity. For example, a theory may be considered as innovative within the field of pedagogic theory and research if its application leads to important re-conceptualisations and opens up new research areas but it may *not* constitute a school-specific pedagogic innovation exactly because it has not yet been transformed, in one way or another, into school practice. As implied by the above, one can be innovative in school education without engaging in the process of inventing a new ICT tool, or of developing a theory and new scientific knowledge through formal research and development. Teachers can be highly innovative by implementing, for example, existing ICTs tools into their own pedagogic practice thus transforming both the processes and the outcomes of teaching and learning.

Integration into teaching and learning praxis is an important requirement for school-specific pedagogic innovations but something more than is needed to be considered as innovations *per se*. School innovation should not be equalled to experimentation that one can engage in to investigate, for example, how an ICT tool or a theory may be applied to school teaching and learning. Experimentation is an integral part of any innovation process but it is not innovation *per se* because innovation, unlike experimentation, needs to be proved that is

effective, i.e. that it leads to the improvement of existing educational/pedagogic practices or that it results to new processes and outcomes of profound educational value.

1.2. Defining pedagogic innovations with the use of ICTs in schools

Providing a working definition of ICTs-related pedagogic innovations in schools we suggest that *pedagogic innovations with the use of ICTs in schools are those activities where innovation agents integrate existing or new ICTs-related pedagogic theories, knowledge, processes and/or products in schools where these theories, knowledge, processes and/or products have never been applied before, leading to evidence-based improvements or desirable changes in teaching and learning processes and their outcomes.*

The above definition is "pedagogy-independent", i.e. is purposefully wide enough to include *any* potential improvement or desirable change in school teaching/learning processes and their outcomes with the use of ICTs. However, there is a dominant trend to identify as innovations *only* those improvements or desirable changes that depart from the traditional, and in many cases traditionally perceived, teacher-centered school culture. For example, in the context of the SITES m^2 project[1], which aimed to study pedagogic innovations with the use of ICTs in 28 countries worldwide, a number of pedagogic practices were identified as indicators of innovation. These indicative practices:

- Promote active and independent learning in which students take responsibility for their own learning, set their own learning goals, create their own learning activities, and/or assess their own progress and/or the progress of other students.
- Provide students with competencies and technological skills that allow them to search for, organize, and analyze information, and communicate and express their ideas in a variety of media forms.
- Engage students in collaborative, project-based learning in which students work with others on complex, extended, real-world-like problems or projects.
- Provide students with individualized instruction, customized to meet the needs of students with different entry levels, interests, or conceptual difficulties.
- Address issues of equity for students of different genders or ethnic or social groups and/or provide access to instruction or information for students who would not have access otherwise because of geographic or socioeconomic reasons.
- "Break down the walls" of the classroom –for example, by extending the school day, changing the organization of the class, or involving other people (such as parents, scientists, or business professionals) in the education process.
- Improve social cohesiveness and understanding by having students interact with groups and cultures that they would not interact with otherwise.

The above generic practices define a common starting point for 174 case studies in a diverse international setting that included countries in Europe, North America, Asia Pacific, Africa, and South America (Kozma, 2003; see also Kozma and Anderson, 2002; Mioduser *et al.*, 2002; Harris, 2002; Ainley *et al.*, 2002; Hinostroza *et al.*, 2002). The analysis of these case studies suggested that pedagogic innovations with the use of ICTs are likely to involve significant changes in the "traditional" roles of the teachers and students. A large majority of case study reports indicated that the teachers acted as *organizers* of students' learning activities, students' *guides* and *advisors*, and *collaborators* with other teachers as part of the innovation process, while only in a small minority of innovation case studies teachers also acted as *lecturers*. On the other hand, students tended to assume the roles of *researchers* (mainly in information seeking activities), *designers* or *creators* of products, *publishers* and *presenters* of their work, and *collaborators* with other students (inter and intra-group collaboration, occasionally including international collaboration). Furthermore, changes in pedagogy were associated mostly on two patterns of practice, one focused on *information management* and another on *collaborative research.*

In two other international projects, the *Merlin* (Scheuermann *et al.*, 2001) and *Sypredem* (see Kollias and Kikis, 2002) projects, which meta-

1. The Second Information Technology in Education Study: Module 2 (SITES: M2) is an international study of innovative pedagogical practices that use ICTs. The study is sponsored by the International Association for the Evaluation of Educational Achievement (IEA). See http://sitesm2.org/

analysed a large number EU funded R&D projects in the area of education and training, similar changes in teacher-student roles and patterns of school practice are identified as indicators of pedagogic innovation with the use of ICTs. Characteristically, teachers in ICTs-related teaching/learning innovations tend to assume the roles of *co-learner* and *collaborator* with the students, *facilitator*, *supporter*, *coordinator,* and/or *guide* of students' work, *(co)developer* of learning materials and software, *researcher* and *life-long learner*. On the other side, students' roles in pedagogic innovations tend to converge with these of the teacher. Significant changes on the roles of teacher and students as those described earlier are associated with:

a) changes in the patterns of teacher-students' interactions which shift from traditional logo-centric, teacher-initiated interactions towards informal, exploratory, student-initiated, and negotiation discourse,
b) changes in the organisation of school life towards more flexible time-tables and learning spaces, and
c) expansion of school activities to include collaboration with other schools and local communities (see Scheuermann *et al.*, 2001, pp. 86-89).

Behind these changes are shifts in school knowledge epistemologies that depart from knowledge and truth as possessions of the teacher or as contents of a textbook which have to be transmitted to students, to knowledge and truth as cognitive constructions and socio-cultural experiences which require active students' involvement.
Deepening our understanding of why and how pedagogic innovations with the use of ICTs emerge, sustain, and diffuse is a demanding endeavour. Reviewing innovations that were implemented in projects co-funded by the European Union such as the *Representation* (Baron *et al.*, 2000) and *CL-Net* (Van Der Meijden *et al.*, 2000) and meta-analyses of innovations in education and training in the context of the *Delilah* (Frade, 1998), *Sypredem* (Kollias and Kikis, 2002) and *Merlin* (Scheuermann *et al.*, 2001) projects, we soon realised that it is difficult to understand and support the emergence, sustenance and diffusion of ICTs-related pedagogic innovations in schools in a piecemeal fashion, innovation by innovation, stage-by-stage. Each pedagogic innovation has its own unique characteristics and yet they all seem to relate to each other in very complex and subtle ways. Each innovation leaves its own trace in the dispositions and practices of the school communities yet all these traces seem to have similar starting points, to follow similar pathways and to have to overcome similar obstacles. Our inquiry led us to innovation studies in the area of economy and technology where the high interactivity and interdependence between different innovation agents and factors have given rise to the idea that innovations can be better understood within a "system of innovation" where important economic, social, political, and cultural factors influence the emergence and diffusion of innovations (Edquist, 1997). This appeared to be a quite inspiring idea and we begun our intellectual journey starting from an analysis of wider socio-economic visions and policy reforms challenging European learning patrimonies which appear to affect, in one way or another, the ways innovation and change in education are conceptualised and enter the policy making agenda and discourse.