MODELLINGSPACE: THE SETTING UP OF HUMAN NETWORKS AS VITAL PART OF THE DESIGN AND IMPLEMENTATION OF A TECHNOLOGY-SUPPORTED LEARNING ENVIRONMENT

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ABSTRACT

The ModellingSpace (MS) project is concerned with developing and implementing a computer-based modelling learning environment in actual school contexts and preparing an education programme for the teachers involved in it. The paper describes the conceptual framework of setting up human networks and developing them into communities of practitioners as part of carrying out this empirical research.

To foster a harmonious integration of the environment and to promote an efficient use of it, the MS project sees the development of pedagogical tools as a process of innovation that involves teachers, as the main actors, from the first stages of the design. Teachers also participate in the building of new knowledge about the development of high level competencies such as modelling, exploratory learning and collaborative problem solving.

In order to describe the complex mechanisms set to work during the implementation phase, a conceptual model is used. This concerns the systematisation of actions so as to focus on the goals of implementation and to control better the variables that could negatively bias any expected effects. The systemic nature of this model is expected to further facilitate the communication of the created expertise. It will thus allow to improve the efficiency of future actions in relation to the use of ICT-rich environments in education while also promoting a more formal "driving" of the associated changes.

KEYWORDS

innovation process, human network, community of practitioners.

1. The Development of a Learning Environment conceived as an Innovation Process: the Example of ModellingSpace

In order to foster a harmonious integration of ICT products and, through this integration, to promote an efficient use of them, it appears essential to conceive the process of development of

pedagogical tools as a process of innovation that involves the main actors from the first stages of the design (Depover and Strebelle, 1997). By neglecting the context of use, the risk is high to develop products that will not be used or will be misused because they are too far from the familiar ground users (Depover et al., 1993). Indeed, the resistance to change in education is proverbial: when teachers are not 'owners' of certain solutions, the 'not-invented-here' syndrome could be a main obstacle to innovation.

In this frame, teachers who are involved in a development project are not seen only as privileged users of a new software, but also as active participants in the whole process of creating the environment as well as the pupil activities within this environment. The ambition of the approach which is proposed in this paper is to make teachers play the role of agents - genuine creators - of knowledge. This is decisively valuable for them and for the education community.

The project ModellingSpace (MS), in the framework of which the research presented in this paper is carried out, is centred upon the development and testing of an open learning environment designed to help students 11-17 years old develop modelling competencies. Moreover, and in addition to supporting teachers to adjust their teaching with regard to the use and creation of models, one of the aims of the project is to provide software designers and developers with a resource which could facilitate their efforts in creating more efficient ICT learning environments.

The material developed in association with teachers is not only in terms of software but also of documents designed to foster an interdisciplinary use of the software package. The MS environment is conceived to be consistent with curricula in the four countries participating in the research, which are Belgium (French speaking Community), France, Greece and Portugal (Fig.1). The software has an interface allowing use in four languages (English, French, Greek and Portuguese). As it is a completely open environment, its utilisation can be considered in the teaching of diverse subject matters such as mathematics, physics, chemistry, biology and environmental education.

The learning environment enables students to work on different categories of models of qualitative, semi-quantitative and quantitative relations. It allows pupils not only to express, build and test their own models, but also to create models through close collaboration with other students and teachers via the internet.

From the above, one can easily understand that the intervention strategy which will be discussed in this paper inscribes itself in an ICT use context characterised by a very high diversity of modalities of usage.

2. Involvement of Innovators - Teachers' Networks

The care to privilege the actors' involvement has led the project consortium to inscribe itself into an approach of participatory research during which teachers, designers, developers and researchers work together and learn from each other. In this perspective, the setting up and maintenance of human networks play a central role in the innovation process. The purpose is to create a community of practitioners that makes possible for everyone who is involved in the project to share the problems that s/he meets in leaving the stability of his/her usual practices and getting involved in the uncertain ways of the innovation.

The MS research is articulated in two main phases: a first phase dedicated to the conception and development of the tools and a second centred on their validation and finalisation. The two phases are planned to last thirty months in total, from April 2001 to September 2003. The

human networks were set up in the initial phase. Towards this end, contacts were made, on the one hand with education officials who could help the project partners to identify teachers interested in the educational use of ICT; and on the other, directly with teachers previously associated with research activities.

At the same time the project took care to ensure an adequate diversity of the research cases, even though the principle of voluntary participation on which the research process is based necessarily put the focus on teachers inclined to open-mindedness with regard to the innovation. In other words, our sample consists mainly of teachers-innovators.

The MS project partners have all selected teachers who teach in schools within the particular geographic area of their university (see the European map drawn in Fig.1). This offers the researchers easier access to the schools. It makes indeed easier the provision of assistance where and when needed as well as the organisation of meetings between the members of each national network. These geographic areas are: the "Province du Hainaut" in Belgium, the "Pays de Loire" in France, the island of Rhodes in Greece and the Lisbon area in Portugal.



Fig.1: Location of the four national networks of schools involved in the ModellingSpace project – Map of Europe

3. A systemic Modelling Process

To improve the reliability of the data and the scientific interest of the research conclusions, we have chosen to describe the innovation process using a conceptual model (Depover & Strebelle, 1997) (see Fig.2). However, the ambition of this model has to be placed above all in the research for systematisation of our actions, so as to focus better on the goals of the implementation and to control better the variables that could negatively bias any expected effects. The systemic nature of the model is expected to further facilitate the communication of the created expertise and to allow, by re-injecting the information collected on the occasion of

an innovative process, to improve the efficiency of our future actions while also promoting a more formal “driving” of the process of change.

The modelling process has as starting point an “at the very outset” analysis of the variables capable to influence an innovative process, articulated on three levels that compose the dynamic axis of the model: the "entrants", the process and the "extrants". The dynamic axis of the model is completed by a topological axis that defines the different subsystems with regard to which the innovative process inscribes itself. From the most specific to the most general, they are: the micro-system constituted by the class; the meso-system made up by the immediate school environment, particularly the local managers, and the macro-system at which level one can find the administrative managers and the policy makers of the educational system. To these three subsystems, which are answerable to the educational system at large, we add the peri-system that groups all the variables present in the immediate environment of the educational system and capable to have an effect on it.

The formalisation of a process of innovation through the dynamic axis of the model begins by a very accurate characterisation of the entrants (level 1), in other words of all the elements that are going to have an influence on the system and which could act as facilitators or inhibitors in the process of innovation. At this level, one can find a certain number of variables capable of exercising an influence on the dynamics of the innovation process: the teachers' competence and confidence with ICT and with certain innovative methodological practices, that is their receptiveness to innovation; the entering profile of students (general level and experience in the usage of ICT); the school’s profile (ICT resources, communication climate, overture of the local managers and of the parents associations to the innovation); as well as the school's image in the community.

The second level of the model makes us enter into the actual process of innovation. One can conceptualise it in the shape of three distinct phases with regard to the nature and the scope of the decisions that are taken: the adoption phase, the implementation phase and the routine phase.

The adoption phase is defined as the decision taken by the teacher to change something in his/her practice either by personal conviction or under an external pressure exercised by the micro-system (at the students’ demand for instance, or/and at the initiative of the school management or the inspectors). It is clear that the decision to change has different psychological repercussions on the teacher according to whether s/he is initiating the change by him/herself or is enduring it as imposed from outside (variable “origin of change”). In the current project, the researchers aim to create the conditions of an endogenous change, that is to encourage a change which originates from the teacher himself/herself.

Another variable that seems strongly linked to the decision of adoption, depends on the teachers’ feeling of personal mastery and confidence with the new tools used in the innovative practices (variable “modalities of teachers education”). For ICT innovations the role of this variable cannot be neglected even if it is known that technical mastery of the tools is very often not sufficient for efficient conduct of the innovative process.

The implementation phase corresponds to putting in a concrete form the declared will, expressed during the adoption phase, to formulate a process that leads to a modification of educational practices. Centred on action, this phase is naturally rendered by perceptible modifications at the level of educational practices but also in the environment in which these practices are set up. In this phase the researchers realise systematic studies that allow them to assign mechanisms of innovation to the modelling process.

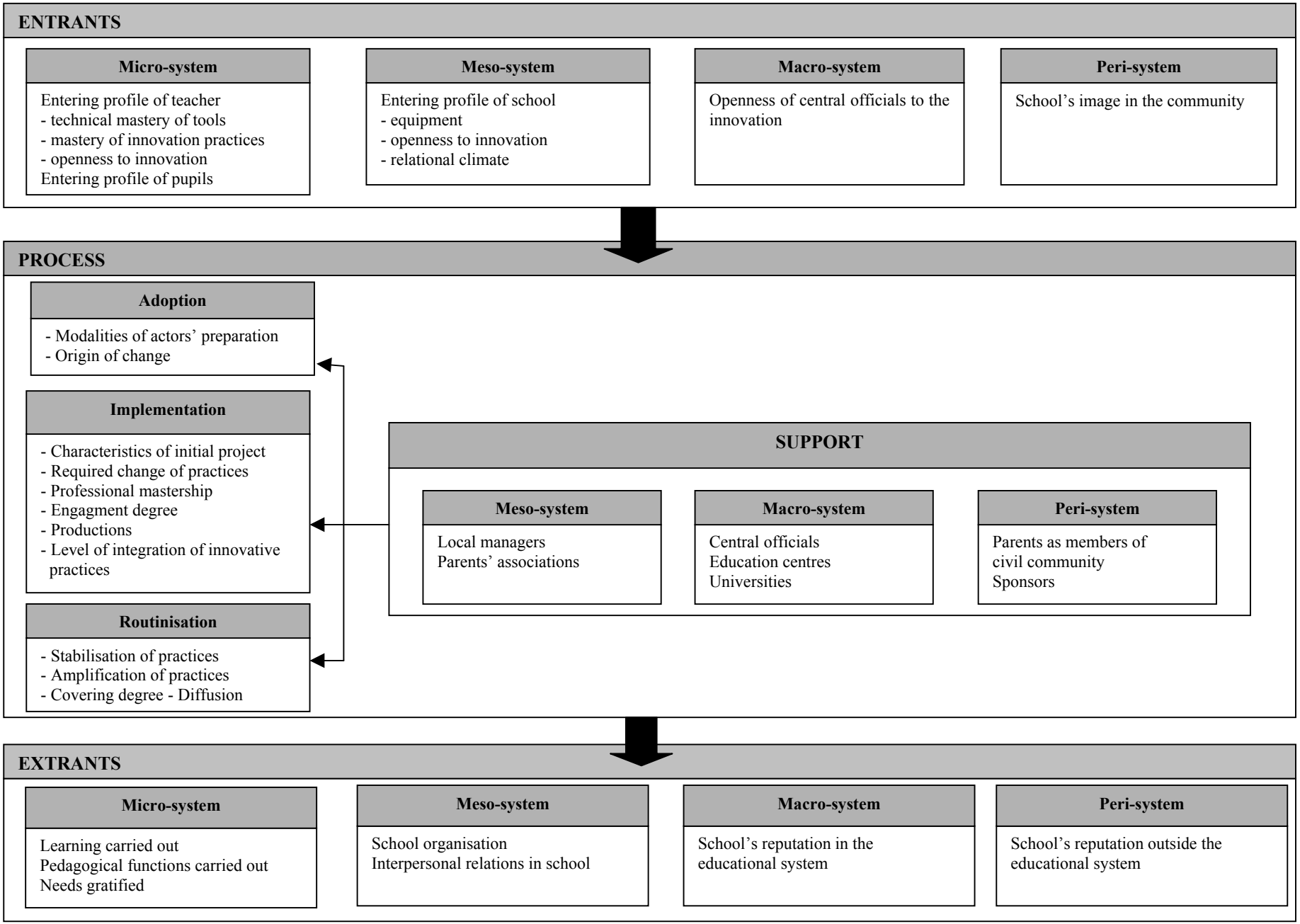


Fig.2: A systemic model of school innovation process

In our model, the implementation phase is analysed through different variables: the characteristics of the initial project; the changes in a teacher's practices; his/her feeling of professional competence; the efforts made by the teacher in his/her role of actor of the innovation process; his/her degree of involvement; the characteristics of the activities realised by the class; and the degree of integration of the innovative practices.

The long-term establishment phase of an innovation is usually described by the word 'institutionalisation'. For our part, we prefer speaking of 'routinisation' because the word 'institutionalisation' makes a too direct reference to an official reconnaissance, and this is far from being the only strategy by which an innovation can be implemented in the long term at the level of the educational practices. To distinguish the beginning of the third phase, one essentially refers to the fact that the new practices are employed on a regular and integrated to the usual school activities basis without requiring an external support from a research or pedagogical team.

Another criterion that is often taken into account to judge the progress of the innovation process is the target range of this innovation. In a practical way, it could be very variable since it can cover from the whole educational system to few classes united by common pedagogical concerns (covering degree). The geographical proximity has been considered for a long time as a factor favouring the diffusion of an innovation. At the present time, the growth of the telecommunication networks makes us put into perspective the importance of this mode of diffusion by privileging the community of interested parties that can be set up beyond the constraints of distance.

The variables linked to 'support' refer to the decisive role that is played by the central managers (administrators, inspectors, etc.), the local managers (school managers, pedagogical co-ordinators, etc.), the initial and further education and training institutions (structures, centres, etc.), but also by certain intervening agents, external to the school institution, properly so called the 'peri-system', such as the parents and certain resource organisations (particularly sponsors of equipment), or even by the public opinion as a whole.

The third level of the model concerns the characterisation of the extrants through the analysis of the effects of innovation on the different subsystems apt to operate on the innovation process or to be affected by it. At this level, one is interested in the effects on the micro-system in terms of realised learning, of pedagogical functions carried out and moreover of the gratification of teachers' and pupils' needs; on the meso-system, in the school management and the nature of interpersonal relations in the school community; on the macro-system and the peri-system: in the effects on the school's reputation, particularly in the opinion of the parents but also of the whole community as well as in the effects on pupils' enrolment.

4. A semi-quantitative Methodology

To succeed in achieving with a maximum of precision the spreading out of the innovation process through an inter-cases analysis, the sampling of cases must be realised according to an accurate methodology. It is essentially the systemic model described in section 3 of the current paper that orientates our choices in this matter. So, each one of the identified variables at the 'entrants' level as well as certain variables linked to the 'process' level constitute respective sampling parameters, which the researchers strive to take into account when selecting the classes that will participate in the project.

Each one of the variables appearing in the model presented in Fig.2 can be described in different modalities (for instance, the variable "ICT equipment" is described according to

seven modalities as it is shown in Table 1). In this manner, one arrives very quickly at a number of combinations, which cannot be possibly taken into consideration. A first approach to attempt to manage this complexity consists of fixing certain variables by limiting the scope of the study. For instance, the variable “modality of teachers’ preparation” must be, at least partially, preset by offering to each teacher involved in the project a specific training in the use of the pedagogical and technical tools that s/he has to implement. Another important decision we have taken, that concerns this time the teacher’s profile, is to choose teachers characterised by a high innovative potential - taking into account their previous involvement in innovative activities and their participation in a series of preparatory activities related to ICT use in school environment. Moreover, before being involved in the project, teachers are also asked to adhere to the terms of a contract that insists on the change that will be expected from their part.

By taking into account the requirements of the MS project already mentioned, a sample of ten cases located in four countries (Belgium, France, Greece, Portugal) has been chosen according to various sampling dimensions such as: type of school, school size, social background of the school, existing ICT resources of the school, computers and internet access, teachers’ training and competence/confidence in ICT and class level.

Let us point out that according to the number of sampling dimensions, each case retained composes a singular configuration which, in terms of validity of the results, can constitute a weakness since it is not possible to appreciate the variance which may appear between two cases that present the same characteristics. On the other hand, the variety of the parameters retained which constitute our sample is such that the results would provide a rather good image of the diversity of the integration processes inside the four European school systems concerned by the project. As Huberman and Miles (1983, 1991) recommend it, we have attempted to thrust away the limitations linked to the smallness of the sample by taking into account a wide range of actors, events, processes, effects and subsystems "so that the results characterise a whole set of cases much wider than what we could legitimately conclude on a statistical plan" (Huberman and Miles, 1991, p. 62, our translation).

The data collection in the field is carried out according to an ethnographic process in a twofold care to collect a maximum set of data with regard to their nature and to place these data in the context in which they have been collected. Dependent on this process, the raw data collected during the case studies are of different kinds: teacher interviews and interview notes taken by the researcher, in-class systematic observation notes, copies of pupils’ written activities, reflective notes written by the teachers and teacher forum reports.

To facilitate the analysis work and to assure the precision of the process, these raw data are arranged according to the different variables identified in the model of innovation. In this way, for each case one disposes of a formal and accurate description of its characteristics in terms of each of the variables: entrants, process and extrants. On the basis of these descriptions, drawing their inspiration from the methodology proposed by Huberman and Miles (1991), the researchers draw describing matrices by case and between cases.

To illustrate the way these matrices are build up, we present an example (Table 1) which concerns one of the variables of entrants, that is the entering profile of school in terms of ICT equipment. To situate globally the level of school equipment, this variable has been put in concrete form through seven criteria organised in two groups: a group which is related to the computers which are available for pedagogical use in school (number of computers available for teaching in school; the number of pupils per computer available for teaching; the ages and location of these computers in school). With regards to the resources and finances for ICT purchase, maintenance and use, we look into the ICT equipment funds, the school annual budget for ICT and the process for ICT purchase.

SCHOOL	COMPUTERS FOR TEACHING				ICT RESOURCES AND FINANCES		
	#	# pup /com	Ages	Location	Equipment Funds	Annual Budget	Purchases Process
BELGIUM (FRENCH SPEAKING COMMUNITY)							
Mouscron ISC-SF	46	16	0-3 years	1 Multimedia library with 37 1 Multimedia room with 1 8 Classrooms with 1	Regional programme School budget 3 teachers' own computers	2500 euro Increased	Teachers' and pupils' requests to a "cybermedia" team constituted by the school manager and 7 representatives of the teachers who meet once a month
Charleroi CECS-LG	19	38	3 years	2 Laboratories with 8 1 Multimedia room with 1 1 Teachers' library with 2	Regional programme	Recurrent Decreased	Teachers' and pupils' requests to the ICT team which transmits them to the financial officer or school manager
	(50)		1-4 years	2 Laboratories reserved for computer and ICT teaching	Special budgets from the city		
La Louvière ISM-ESG	19	43	3 years	2 Laboratories with 8 1 Multimedia room with 1 1 Teachers' library with 2	Regional programme	4000 euro Increased	ICT team's proposal to manager Proposal and provision by catholic network
FRANCE							
GREECE							
Ialysos 1PS	11	27		1 Laboratory	Ministry of Education Parents' union Specific project	No	Teachers' request to parents' union Government support
Ialysos 3PS	9	39		1 Laboratory	Ministry of Education Parents' union	No	Teachers' request to parents' union Government support
Rhodos 3GR-VKG	8	44		1 Laboratory	Ministry of Education	No	Software provided by government
Rhodos 1LR-VKL	13	23		1 Laboratory	Ministry of Education	No	Software provided by government
PORTUGAL							
Brandoa EB	14	60	0-4 years	1 Laboratory with 12 1 Library with 2	School budget	No recurrent	Teachers' and pupils' request to manager
Monte ES	44	18	0-10 years	5 Laboratories 1 Library with 4 2 Classrooms with 1	National program National prices	2500 euro Increased	Teachers' request to manager

Table 1: MS schools networks - School equipment, resources and finances for ICT (September 2002)

5. An Internet-based Support "just-in-time" and "on-the-job"

Even if the contact teachers who lead the work of ModellingSpace in the project schools have received some ICT training and have at least a basic level of competence and confidence in its use, it is not necessary the case of their colleagues who are involved in the project. On the occasion of the meetings that have occurred during the first school visits, the majority of the teachers have made it clear that they would welcome more education and training to improve their ICT competence and expertise. As a consequence of this, a programme for teachers' professional development has been conceived. It is a mix of initial training on the software to be used, initial and ongoing teacher education on modelling, on exploratory learning and on the teachers' function as contributors to participatory research, and the creation and use of a digital support system.

According to Reynolds (1998) an important factor in staff development is the support available. To make the support available for the teacher at any time s/he needs it, a virtual space dedicated to the teacher has been created in the MS website, called 'Teachers' Space'. (Fig.3). It is a password-protected area for teachers in which they can communicate and collaborate by means of different tools that have been set up for their use: agenda, FAQ section, glossary, forum, chat, whiteboard, etc.. This Teachers' Space is constantly enhanced on the basis of experiences gathered. Moreover, the teachers themselves are actively involved in the development of their space by inserting reflective notes describing their reactions regarding the activities carried out in the classes. In this way, the contributions of the teachers constitute a situated knowledge which complements the information and the tools provided by the researchers derived from their experiences and from the MS project as such. It is the task of the researchers to translate teachers' needs and wishes as well as possible into digital resources made available to them at distance from the MS web site.

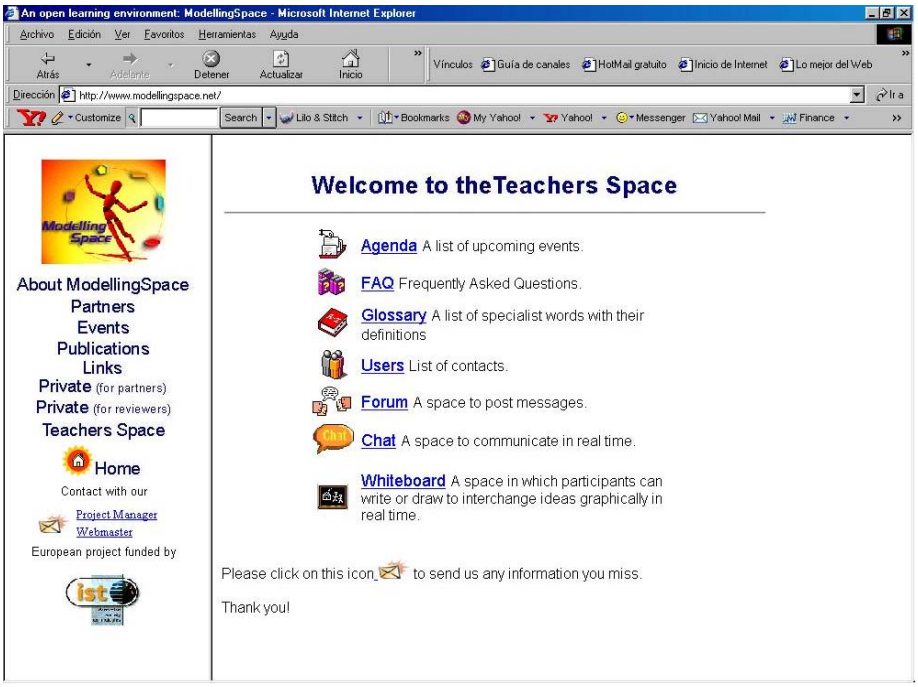


Fig.3: Welcome page of the Teachers' Space in the ModellingSpace web site, with links to services available for the users

The Teachers' Space in the MS web site is thus to be considered as a space where the teachers can find information about the project; a space for supporting education and training during the

period of first use and all along the life of the project; a space for collaboration amongst teachers while they are using the software in the classroom; and a space for communication between the teachers, the developers and the researchers.

6. Towards development of a Community of Practitioners to generate and implement Innovation

Nowadays, it is fashionable to talk about 'communities'. Numerous studies refer to it to justify more or less intensive exchanges between people who are involved in a common project or who share the same interests. For authors such as Wenger (1998), the concept of community implies the existence of a micro-culture upon which the exchanges in the group rely.

In order to create a "belongingness" feeling apt to constitute the ferment of a proper culture, several mechanisms have been set up in the MS project: at first, common activities to be realised at distance that imply interactions through synchronous and asynchronous tools of communication; secondly, spaces of exchange for the different categories of actors (pupils, teachers, local co-ordinators, researchers) wherein each one can express his/her difficulties as well as his/her successes; finally information and resources regularly updated and available at distance.

As we have already underlined, our work of analysis and modelling of the innovation process is above all oriented towards action: to understand better how the things happen in order to act on the educational process to make it more efficient and to focalise it on certain effects considered as positive. To sum up, the question is to create the dynamics of innovation by considering, in order to maintain and strengthen it, the present means of the ICT, but also, to set up tools for systematic data collection, which permit one to observe, analyse and understand how new pedagogical products can be implemented in the school system.

In the framework of the centripetal process that is adopted in this study, and which is grounded on teachers' innovative potential, it is important to set up internal regulation mechanisms that permit us to choose which measures to promote, by relying not only upon common-sense criteria but for the most on results of systematic validations and testing. These mechanisms must also allow to canalise the most promising practices in terms of effects on pupils, but also on the other potential recipients, who are teachers, the school, parents and the educational system as a whole. To canalise does not mean to censure; consequently it is well in the respect of the ideas, the practices and the interests of each one that this regulation must operate for the welfare and the development of all the actors involved, pupils as well as teachers, managers and inspectors.

Let us emphasise that, even in an innovative process that rises from the teachers' motivation such as of those we have presented in this paper, it is difficult to consider the person as free every instant to choose to adopt or not to adopt a singular educational practice. In general, his/her decision is somehow or other conditional to a material or technical support environment or yet to an administrative decision that defines the legislative framework inside which the people must operate. The adherence to the curriculum that is often mentioned by the teachers, even by those who have been identified as having an important innovative potential, constitutes a meaningful example of this conformity to certain rules.

As Fullan (1991) emphasises, the innovative process is above all a personal experience, relatively to which each one can adopt very different positions depending on his/her previous experiences and on the environment in which s/he is situated. Thus it is in systemic terms that we try to understand the innovative process in order to be able to act then on it. Moreover, it is

important that this action is taking into consideration the origins of resistance, which does not fail to appear as a natural reaction of the system towards the instability that goes with every process of change.

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