How do We Innovate by Researching? The Role of Research Projects for the Development of ICT-Based Educational Practice

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1. Research Projects on ICT as Innovating School Practice

When we deal with the development of pedagogical use of ICT we cannot infer that innovation only refers to the technological aspects of the communication tools. We are certainly dealing with a complex reality that involves *actors* who use *tools* in complex *processes*, within specific organisational *contexts*.
Innovating school practice via the implementation of experimental uses of ICT is then a process that can be interpreted as analogous to the development of a biological organism, always involved in an evolutionary process, in which every cell is continuously changing according to the development of the whole.
The metaphor of biological development involves the consideration of several dimensions, each in relationship with all the others, and each with its own specific developmental questions:

- Methodological development: what pedagogical practices are able to innovate the teaching/learning processes?
- The human/technological interrelation: what kind of technologies can or should be developed, and what uses of ICT can offer a pedagogical added value?
- The nature of the learning processes in a technologically mediated environment: how can we study it?

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History shows that technology has so far produced developments that often overcome human needs. As Gaudin says, experience has already shown that:

"...si l'on demande à l'industrie d'aller dans la lune, elle le fait ; tandis que si on lui demande de dépolluer, elle ne le fait pas, ou ne s'y résigne qu'en ronchonnant, comme l'enfant qu'on oblige à ranger, bien que ce soit possible, souhaité et reconnu". (Gaudin, 1978, p. 1).

As Gaudin argues, it is not the technical development that promotes or inhibits innovative processes, but rather the behaviour of organisations, which have to be considered as live beings, with their own missions, their own evolutionary paths and their specific ways of functioning.
The potentialities of innovation, according to Gaudin, are not provided by the development of sophisticated tools; the process of change rather relies on the capability of technical arrangements to "suggest" innovation to an audience of potential innovators. It relies on the encounter of technological solutions with listeners who are looking for them. Innovation is then considered as the meeting point of technological and human factors.
What can we consider as potential innovation? How can we research methodological innovation? And how can we transfer the results of research innovation into implementation and scaling-up of good practices?
The main challenge for research projects devoted to experimental pedagogical uses of ICT is not only the development of good practice in itself,

The CI-Net project

The CI-Net project was a two year project funded in 1998 by the European Commission under the TSER programme.

The main objective of this project was to investigate the cognitive and didactical aspects of computer-supported Collaborative Learning Networks (CLNs). CLNs are learning environments in which educational technology is used to help create *a community of learners who build knowledge together.* The central question of the project was: How can effective knowledge building in CLN's be supported in European primary and secondary education? This research was conducted by 11 senior researchers and 15 junior researchers from 5 countries (Belgium, Finland, Greece, Italy, and The Netherlands).

Almost 600 students from primary, (age 10-12), secondary (age 13-16) and vocational education (age 18-24), and 25 teachers from 20 schools participated in this project, experimenting with different kinds of software.

Three kinds of measurement instruments were used: 1) protocols of communications between students and between students and teachers. 2) Tests that measure the cognitive, meta-cognitive, and motivational effects of CLN's. 3) Small questionnaires and interviews with teachers and students to find out which tools, support structures, and manuals function the best. In all the case studies conducted during this project, different positive effects were found, but in general, the results obtained in the case studies suggest no robust effects that could be considered as a common finding across the individual projects. Some rather consistent evidence was found suggesting that, during the course of the project, many students showed less interesting superficial engagement and more interest in collaboration. Motivation increased in almost all test sites. The findings gained from the different test-sites where cognitive effects were measured and reported show significant advantages of introducing Computer Supported Collaborative Learning (CSCL) in classrooms.

but the development of practices that are valuable under the stakeholders' eyes. Research projects become valuable, first of all, when they produce evidence that experimental practices can be implemented and when they have an added value for the practitioners.

In this perspective, innovating pedagogical practice cannot be managed as a top down process. Its effectiveness is strictly related to the degree of relationship among all the actors that are directly involved in the educational process.

In the following paragraphs we analyse the main dimensions affecting innovation potentialities of some research projects devoted to the didactical implementation of ICT.

First, we present an experience of a European research project in which ICT was used in different educational sites: the CL-NET. This project is relevant because it is one of the first attempts to scale-up innovation in Computer Supported Collaborative Learning in Europe and to understand the different dimensions playing a role in the process of innovation via implementation of ICT in school. Most of the outcomes of the CI-Net project could be generalized and are treated as starting points for theoretical, practical, and methodological reflections.

Secondly, but still in connection with the practice realised in the CL-Net project, we analyse the theoretical approaches more frequently used by research projects devoted to testing out innovation potentialities for didactical implementation of ICT.

The third point discussed in this paper comes from the conviction that tools used to support learning are not neutral. In order to sustain innovation, it is important to know the features of tools and the effects of their integrations in complex and rich technical environments.

Finally, we concentrate on the research methods that allow innovative processes to be observed and described in a way that all the components can come into view. The identification of research methods is a fundamental step that can assist us in studying the fluidity of the new experiences produced while implementation is taking place in school practices.

2. The CI-Net Project

What follows mainly refers to a research project named CL-Net (see a description in the box below) that was our first international experience aimed at developing good pedagogical practices involving ICT in school (Van der Meijden, Simons, De Jong, 2000). The experience gained with CL-Net allowed us to think concretely about innovation, and several other projects, not discussed in this article, were inspired by it.

3. Collaboration, Constructivism, Community: the Three Theoretical "C"s for Innovation

Working together with different partners on the same educational ICT project (CI-Net) was a great opportunity to compare the theoretical approaches that each partner used. It was then possible to pull out a sort of common background that could be compared with the non-European literature on this topic. Three main streams of theoretical ideas were found to be the most commonly used collaborative learning, constructivism, community developing.

Collaboration

Collaborative learning has definitively replaced the supremacy of learning via "trasmission". Rooted in the Vygotskiian view of the relevance of social interaction for learning, collaboration is considered a way to organize social interaction in such a way that shared meanings and knowledge construction is ensured. A considerable number of scholars, all over the world, looked at how collaboration takes place "inside" the group, through discourse analysis on discussions among peers and between teachers and students and using different perspectives (Billig, 1987; Duranti and Ochs, 1986; Lave and Wenger, 1991; Goodwin and Goodwin, 1987; Pontecorvo, 1990). One of the most interesting results of this stream of research is the discovery that discourse itself functions as a socio-cognitive tool.

When computers started to be considered as tools to support collaboration, the analyses of both discourse around the computer and discourse generated by the computer were found relevant in describing the learning processes supported by computers (Crook, 1994). Later on the focused was moved from the interaction in front of the computer (with others or with the software) to the interaction between people at a distance mediated by the computer. As the internet expanded, the possibility to collaborate with partners at a distance increased enormously. All the different ways computers could support collaborative learning (both at the distance and face to face) generated a new stream of research called Computer Supported Collaborative Learning (CSCL).

The first CSCL conference was held in 1991 and, since then, much research has been conducted under this label. A recent study of Lipponen (2002) analysed the distinctive features of this field. First of all, there has been a strong tendency to formulate more social theories of learning. But, with time, more attention has been given to the context (both local and cultural) in which learning takes place and to the processes of establishing communities within virtual environments. Furthermore, instead of just studying the technical features of the software, CSCL has become interested in the social infrastructure needed to support the integration of technology at school.

Secondly, despite the different definitions of collaboration found across the CSCL studies, as well as many other differences —methods, units of analysis, type of task— there is a growing interest in how technology is used and perceived in a learning context. In fact, Koschmann (2002) recently stated that "CSCL is a field of study centrally concerned with meaning and the practices of meaning-making in the context of joint activity and the ways in which these practices are mediated through designed artifacts" (p. 20).

Constructivism

Another theoretical dimension commonly used by educational researchers in analysing the learning processes is constructivism. Constructivism refers to the idea that knowledge is not given in the real world but actively constructed by the people engaged in a process of making sense of what they experience. The idea of meaning making is again central and it runs parallel to the shift from constructivism to socio-constructivism in contemporary educational psychology. Constructivism becomes co-constructivism and later socio-cultural constructivism in order to underline the social and cultural influences on this process. Starting from the criticism of the classical cognitivist approach, where computers were meant to simulate the mind and its behaviour, socio-constructivism has introduced and underlined the concept of *interactionism* as the new engine. Constructivism is only possible within and through the social relationship.

Within the most recent cultural models, there are radical approaches of constructionism and of the psychology of discourse within which thought is seen as an intrinsically argumentative and rhetorical process (Billig, 1991; Harré and Gillet, 1994; Pontecorvo, 1997). At the heart of this type of interaction there is a "moral" dimension: what we believe about the world, the others and ourselves. Thanks to this dimension, not only the aims of education change, but even the evaluation methods: from testing individual students to analysing the quality of the processes that sustain social construction of knowledge. These new directions pushed educational psychology to study the complex relationship between educational processes and the social contexts within which learning occurs (Gergen, 2001).

Computers were introduced as further tools, innovative and with new additional features compared to traditional tools, to support the construction of knowledge. In much research, the knowledge construction took place in two forms: *a)* Products on computers. This type of product, besides being built through the computer, is only visible on the computer. It is the case of products such as hypertext, hypermedia, and CD-ROM; *b)* Products through computers. In this case the computer is only a tool to build a certain product. Schools' magazines, posters, books and other products are built by using the computers just as support to obtain other types of products.

When looking at the impact of constructing through computers, again the discourse generated during the constructive activities is considered an important indicator. Also analysed is how organization inside the classrooms is changed by introducing computers and how new practices and new insights about the learning processes are generated around computer-based activities. When software programs are built to sustain, not only the construction of a product (whatever form it has), but also to support new ways of thinking and of interacting, then Scardamalia and Bereiter (1994) talk about *knowledge building.* Outcomes of the knowledge building process are new cultural products, in terms of new ideas and understanding as well as in terms of construction of "physical" objects. For Paavola, Lipponen and Hakkarainen (2002), the concept of knowledge building overcomes the dstinction between the cognitive and the participative perspectives on learning.

Community Development

If the main goal of education is the collaborative construction of knowledge, then the classroom has to work as a community, because only communities actually build knowledge. The model inspiring the community of learners (Brown and Campione, 1990; Brown and Campione, 1994) comes from two other communities, similar in their ability to produce knowledge but different for the types of knowledge produced: the community of scientists and the community of craftsman. With the increase of the social dimension in analysing the learning processes, the community became "community of practices" (Wenger, 1998). This model sees a relationship between the quality of the knowledge produced and several social processes, such as negotiating a common goal, discussing a mutual engagement, and developing a common repertoire. More recently, computers are seen as tools to develop and sustain communities working at a distance (Kim, 2000). Organising the classroom as part of a virtual community can be considered as a further development of the constructivist and collaborative dimensions. It increases the number of actors working to the same task and enlarges the class community including the outside dimension. One of the problems found in the attempt to use computers to support "virtual" communities, comes from the tendency of using computer to produce, rather that to communicate. This attitude seems to interfere with the idea of using computers to communicate. Computers are seen as tools to achieve end-products and not to foster the processes necessary to realize a collaborative product. Computers and the Internet are perceived as "windows" to show classroom final products rather than as tools for discussing what to do and how to plan collaborative strategies.

4. Intercultural Diversity on Pedagogical Models: *"Do We Speak the Same* Language?

Within the CI-net project, the way pedagogical innovation was perceived evolved along the project. At the out-set of the project, some of the core concepts conceived as connected to innovation in the school practice were implicitly considered as commonly understood by all the partners.

For instance, the concept of *Collaboration*, which was one of the main leading ideas of the project, was discussed in depth only after the partners were actively involved in the operational phase and the didactic activities were implemented in schools.
At that point, it became evident that what was considered to be innovative for collaboration at a local level differed from country to country. The contextual organisation needed to support collaboration at school was conceived in different ways. Each country exploited diverse experiences concerning collaboration at school both in terms of interaction between sites (i.e. collaboration within the classroom, between classes, international collaboration) and in terms of tasks planning (independent versus interdependent tasks).

Innovating School Practice at Local Layers

The variety of "experiments" developed in the CL-Net framework added value to the project, giving interesting insights about how to "locally" organize and sustain pedagogical innovation. Researchers had the possibility to conduct experiments situated into real practices and to understand how to implement ICT for effective pedagogical practices. They could work at the project, not only developing academic practice and research, but also being in direct touch with the main actors and working with real school practices and contexts. They had the possibility of establishing scientific communities where teachers and students were entitled to participate. In this way good practices based on pedagogical uses of ICT integrated into the school system were developed. This was possible because multiple perspectives were taken into account at the same time: effects on students, didactical applications, theory develop technological solutions, and organisational aspects of the school context.
Such a complex and interactive scenario was only possible by developing strong synergies among all types of participants and by supporting each of them by assuming the others' perspective: for instance, teachers acting as researchers when activities needed to be planned; students becoming teachers when approaching a new software; researchers assuming the teachers' point of view in trying to understand the classroom's limits and potentialities.

All partners made strong efforts in teacher training activities, and there was a specific task for developing a "Teachers' starters kit" for the training of teachers who are novices in the practice of ICT. The kit was developed and used on an international basis. For the development of the kit, all the most significant experiences and the best known practices of the participating countries were collected and analysed in order to sum up the characteristics of good pedagogical practices both at a local and at an international level.
Other than the development of the starters' kit, the implementation of all the experiments in the framework of the *CI-net* project was supported by a professional development phase in which the participating teachers were involved.
Innovation at school was introduced as a shared activity between researchers and teachers. According to the action-research model, teachers acted as researchers in many of the experiments planned. An innovative aspect of the implementation of CL-Net is that the teams of teachers were intended as communities of practices local communities of teachers sharing a mutual engagement, a joint enterprise and using a shared repertoire were organised on local basis. The main idea was that of offering a social gathering within the schools that could function as a self-supporting structure for teachers involved.
Innovation at school was mainly supported by a continuous training performed both in formal meetings for professional development and on site while the educational actions were performed in everyday school life. Professional development was achieved through different strategies and modalities:

- Discussions with teachers on the topics of activities.
- Teacher training on technology.
- Presentation of technology to the students.
- Monthly meetings in the schools with teachers to plan activities.
- Weekly visits in the classes during project-related activities (also non-telematic ones).
- Empowerment of teachers as main actors.
- International Teachers meeting.

The most positive aspect of participating to the CL-Net experience, as teachers revealed in a follow-up interview, was that they have been

strongly supported by the research group both in technology and in didactical management on site. Moreover, they could plan and run their own collaborative projects and they did this by participating in a community of practice. Also students' participation was characterised by non-traditional ways of learning, as activities were strongly motivating, based on autonomous management of the learning situation. According to this, communication was based on significant interaction with real interlocutors.

The "experiments" done in the framework of the CL-net project were primarily meant as the try-out of good practices. The amount of support offered to the teachers involved is hardly feasible as a regular professional development practice.

Nevertheless some core matters dealing with the sustainability of the project can be identified on the basis of that experience. Innovation can be introduced at school if supporting activities are planned and if the didactic activities are consistent with regular school practice planned by teachers.

5. Tools Supporting Constructive Cooperation within Educational Communities

In order to have a successful mediated collaboration among partners working at a distance, several tools are available. Important aspects of each tool do not concern simply the technical potentialities, but also the way those tools can be used. It is important to have a clear idea about how communication tools can serve pedagogical and social aspects, and how they can be employed to achieve the fixed goals, not only how the tools work. Introducing technological resources to support collaboration at a distance and to enhance communication practices becomes more relevant when complex systems are available for both communication (e.g. e-mail, videoconferencing, chat) and data sharing (electronic blackboard, systems for the exchanging of files). More sophisticated goals can be pursued, higher levels of social thinking can be reached, and collective intelligence is activated (Lévy, 1994).

Nowadays a huge variety of communication tools is available. In the following section we discuss the main issues that can help distinguishing among tools:

a) Those supporting synchronic communication versus those supporting asynchronous communication. Typical synchronic communication tools are the chat-boxes or "avatar"[4] interactions; the most used asynchronous communication tools are email, discussion forums and newsgroups;

b) Those supporting text-based communication versus those based on visual and iconic format. Chats, email, forum, newsgroups are all mainly text based; while bi or three-dimensional software provide a visual environment.

The so called "third generation distance education" (Kaye, 1994) contributes to computer assisted education by offering avenues for introducing students into a real communication network which puts classroom work into a wider context of interaction. The type of communication can be differentiated by its temporal dimension (asynchronous or synchronous). Also the organization of the information exchange can differ (text versus images). These dimensions affect communicating at a distance (i.e. impacting on the sense of presence within the virtual learning space). Most of the virtual environments available at the moment on the Internet tend to integrate and combine many kinds of tools in numerous ways. Thus, it is important to understand the specific constraints (both positive and negative) of each type of communication tool on the style of interaction as well as on the effects for collaboration at the distance.

According to our experience in using different tools for collaborating at a distance, we believe that the categorization discussed above impacts the following aspects:

1) *Telepresence Perception:* as Riva and Galimberti (1998) notice, the physical co-presence of persons was traditionally used in order to distinguish the concept of "interaction" from that of "relationship". Mediated experiences are traditionally interpreted as conveying only interactions but not relationships. It is actu-

4. The word avatar is used to describe the object representing the user's presence in a communication system. Avatar is the face of the Indian Goodness called Vishnu that reincarnates with different faces depending on the mod of the moment. The metaphor well underlines the idea of a temporary and contextual representation of the user's identity in a virtual environment.

ally recognised that a specific type of interaction occurs where most physical cues (normally present in face-to-face situations) are not available, and that each tool offers a specific "rarefied" form of interaction. In any case, the interaction at a distance allows the perception of a sort of "telepresence", depending on the type of feedback as well as on the different degrees of "co-formulation" of the utterances (cfr. Riva and Galimberti, 1998; Mantovani, 1996).

2) *Type of Interaction among the Users:* different types of monitoring and regulation of the participation in the collaborative process are provided by each communication tool. Most of the time, these features are affected by the interactive context and by the specific situation.

3) *Dynamic and Fluid Management of the Learning Process:* the management of the learning process seems not to depend exclusively on personal styles or skills. Communication systems also impact on the tutoring processes. Recent research (Ligorio, Talamo and Simons, 2002) shows that, in synchronous communication, new ways of tutorship are possible depending on the shared management of the learning process.

4) *New Technological Resources for Interaction:* many communication systems offer to users some resources that can be used during the interactive exchange, such as the possibility of playing with unreal identities (using nicknames or personifying avatars), or the construction and use of virtual objects. Some recent studies (Talamo, and Ligorio, 2001) show that these features are strategically used by participants as interacting resources in the negotiation processes during the knowledge co-construction. Creating an identity, not only as a learner, is one of the bases for learning (Nichani, 2000). Wenger (1998) claims this happens "because learning transforms who we are and what we can do, it is an experience of identity" (p. 215).

5) *Types of Metaphor for Learning Contexts:* some of the text-based chat systems (i.e. MOO and MUD) and the three-dimensional virtual worlds foster a spatial representation of the learning context where active building is explicitly encouraged. In some asynchronous systems, spatial metaphors and paths (i.e. the links between information) reflects the relationships between concepts (such as during the navigation through most of the websites on the internet). On the other hand, space in synchronous environments is mostly intended as a dynamic representation of knowledge building. Recent studies show that the spatial metaphor does not fit the representation of what a hypermedia is in terms of information organisation, but gives only a key for navigating through the information according to the producers' expectations and intentions. (See also Boechler, 2001; Carrada, 2000; Talamo and Fasulo 2002). In synchronous systems, the space is itself a product of the interaction among users and it acts as a virtual representation of the evolution of the learning process. This is consistent with the constructivist theory of learning.

6) *New Shared Repertoires:* are co-constructed depending on the communication features. The more the interaction is dialogical and dynamic, the more the negotiation of shared meanings is fluid. The sharing of a common repertoire among learners and all other actors in the learning environment is one of the basic features of the development of a community (Wenger, 1998).

Synchronous versus Asynchronous Communication

When can synchronous communication be recommended as suitable for collaboration at a distance? In general, all the synchronous interactive processes mediated by technological environments are characterised by the arising of new psychosocial and discursive practices and by the absence of the communication practices typical in face-to face settings. Furthermore, synchronous communication allows the study of the collaborative processes in the environments where they occur and while they are taking place. In particular, there are some specific situations when synchronous communication can be very advantageous.

a) To Acquire Information about the Local Context. The climate of the context where users

are working in real life is hard to describe. By synchronically meeting the partners on-line, it is possible to get a better feeling about what type of situation and what type of climate are they involved in. When local contexts are described asynchronously, the information is selected along criteria not always visible. When interacting in an asynchronous mode, information is essentially task-oriented. While chatting, it is hard to avoid talking about who we are and what real context we are embedded in it. This opportunity is particularly useful when users are encountering some problems in their participation.

b) *To Make Decisions and to Express Social Consensus.* Certain decisions are not easily made, especially when there is no centralised organisation. When participants have to make collective decisions, for instance, about specific responsibilities, synchronous discussion helps the process of decision making. Furthermore, decisions made during synchronous discussions are easily shared and acknowledged by all the participants. Comments and remarks are situated at the time of the discussion and the decision may be made more quickly. During on-line chats, it is also easy to require all the participants to express their opinions with the aim of comparing and reaching a social consensus.

c) *To Facilitate Information Analysis.* During collaboration at a distance, it may happen that information is acquired, but the reflective thinking about it is not shared. By organising synchronous group-discussion about the information available, it is possible to reinforce the process of sharing insights and thoughts. In this way all the participants are "forced" to express their points of view and, thereby, move toward a more central participation within the learning community.

d) *To Clarify Ambiguities Generated by other Communication Tools.* Each communication tool has limits and potentialities, thus ambiguities can be generated thorough any of them. One of the most common problems of asynchronic communication, such as the discussion forum or mailing list, is that often messages do not get a reply because is not clear who is in charge of the answer. If replies are needed in order to continue the work, it is more likely that participants will contribute their answers during a chat.
However, asynchronous communication seems to offer other types of resources and to be more convenient in some situations.

e) *Differences in Time Zones.* One of the most problematic aspects of synchronous communication is the temporal arrangement. In order to chat, each interlocutor has to be connected at the same time and in the same virtual space. For schools and educational agencies in general, it is not always easy to have flexible agendas. Most of the time, computer availability, scheduling and other organizational issues may constrain the connection to a certain time and flexibility is not at all guaranteed. Issues such as differences in time zone or difference in speed connection depending on certain hours of the day make the coordination of the connection even more complex.

f) *Focus on the Educational Content.* Asynchronous communication allows time for reflecting on what has been posted and on how to continue the discussion. The flow of the asynchronous communication is slow and fosters focus on the content. Establishment of interpersonal relationships is more in the background, although it still possible to sustain more personal communication. Besides the tempo, asynchronous communication systems often require a second order of reflection along with? the posting of the messages. For instance, messages need a subject, and often the discussion forums require an explicit categorization of the content. This is the case of the "thinking types", or scaffolds, sort of labels that the writers have to add to the message in order to clarify the phase of reasoning to which the message belongs (Hakkarainen and Sintonen, in press; Scardamalia and Bereiter, 1993).

g) *Scientific Collaborative Knowledge Building.* Given the previous point, asynchronicity seems to be more suitable for scientific reasoning, where certain phases are clearly identified. Posing questions, collecting information, formulating and verifying hypotheses, and producing new questions: this is a flow of reasoning that seems to be mirrored by the

"threads" generated during the forum discussions (Hakkarainen, 1998).

h) *Individual and Collective Reasoning.* In an asynchronous communication, it is possible to track down individual ideas; it can be seen how those ideas impact the general discussion, how each idea is picked up by the others, and what type of further elaboration takes place by consensus or criticisms. This aspect is often crucial for educational agencies, always concerned about the right attribution of who did what. In this way, it is possible to solve evaluation problems by keeping a clear distinction between individual and group contribution.

Textual versus Visual Dimension

The textual dimension is pretty easy? to observe: email, chat-rooms, forums, and even virtual environments such as Multi Users Dimensions (MUD) use text as the main symbolic system; bi and three dimensional software such as *Active Worlds, Roose*, and *The Palace* are based on photos, pictures, and static and dynamic images. The text-based environment usually supports narrative thinking, while visual tools foster the immersive experience representing spaces instead of describing them.

a) *Age Impact.* While is hard to identify an age impact of asynchronous and synchronous communication tools, in the case of text versus visual the impact is more evident. Text based environments are not suitable for very young children; they are not yet literate and, the visual dimension is very attractive to them.
In general, visual communication tools are recommended when writing skills are lacking and when there is a need for initial motivation.

b) *Different Skills Involved.* Text based environments seem to attract more people with good writing skills and they seem to support dialogical and narrative attitudes. The visual dimension seems to be helpful in overcoming language differences or difficulties. Furthermore, pictures and photos seem to provide a better reproduction of reality. It is still controversial whether the visual reproduction of persons and objects produces a more realistic immersion or whether the imaginary and fantastic dimension fosters creative skills.

The Advantages of Combining Different Tools

Having rich and flexible educational environments is considered a great opportunity for knowledge building and collaborative learning. Computer based environments tend to be designed to include different tools and support several types of communication and collaboration. The integration and combination of different tools within the same technological environment provide mutual enrichment. Both synchronous and asynchronous communication have specific features and, by combining them, certain educational activities can have a higher impact (Ligorio, 2001). In particular the integration of different types of tools allows the following activities:

1) *Interim Evaluation not Parallel.* Theoretical innovation introduced by the collaborative learning approach implies also some changes in the evaluation processes. First of all, learning should be evaluated not only at its initial and final stage but also while occurring. Secondly, evaluation should be also in the students' hands. The combination of different types of communication tools can create occasions to evaluate the learning process in interim and students can reflect on their activities by discussing them, both individually and collectively.

2) *Supporting Collaboration at a Distance.* Collaboration at a distance is not an easy process and it is articulated through different phases. Combining chats and discussion forum, text based and visual information, conflict management and social interaction can be fully exploited. For instance, more points of view are expressed and the discussions will bring in, not only the information relevant to the topic, but also the emotional aspects. Furthermore, by having available both synchronous and asynchronous communication tools, the transfer from the "real" context to the virtual environment and vice versa is facilitated.

3) *Enriching Knowledge Building.* Knowledge building is enriched by use of different types of learning objects (text materials, photos, etc.)

Asynchronous communication represents a "place" where requests, ideas, and discussions can be stored in a more permanent manner creating the possibility of re-reading and reflecting on what has been written. At the same time, the synchronous dimension can resolve ambiguities, can fulfil the need for immediate replies and can give a personalized version of what each participant thinks or says.

4) *Enriching the Interactive Resources.* Interaction seems to be more effective when different types of formats are combined. Recent studies (Talamo and Ligorio, 2001; Ligorio and Talamo, submitted) show how specific aspects of graphical interaction, such as the visualization of the virtual objects or the embodiment of the users in the avatar, are rhetorically made salient during the interactive discourse that is mainly text-based. This combination can be used as a further resource to give useful information about the goals participants have in mind and how they perceive the whole context.
Rich and complex environments created by the integration of different communication formats are relevant resources to use in evaluating the quality of the learning experience and the collaboration process, rather than taking into account only the end product.

6. Ethno-Technology as a Resource for Studying Methodological Innovation

How can we deal with the challenge of studying methodological innovation during its development? The need of descriptive methods has often determined the first steps in the study of new phenomena and processes.
As Grossen and Pochon (1997) propose, there is a need for the development of an *ethnotechnology*, a specific field for studying the impact of technology born of observing differences between the way tools were used and the functions the developers had in mind (Gaudin, 1978, 1988). Ethno-technology is so conceived as the ethnographic study of the real usage of technological solutions.
Studying learning processes, even more when they occur in collaborative contexts, can benefit from the study of "emic" descriptions (Duranti, 1992) of the context itself. An emic description is the reconstruction of the meanings negotiation in the way that is explicitly expressed by the interacting persons. Therefore, studying synchronous communication allows the recording of the mediated forms of talk in interaction (Schegloff, 1987) and allows the researcher to describe, in a emic way, how the learning process proceeds during the collaborative work at a distance and how the technological and human factors impact on each other.
Ethno-methodology and discourse analysis, integrated by the recent methodological research on on-line interactions, are now widely considered as the appropriate methods to describe communication data. From a methodological point of view, this calls for analysis of the negotiation of shared meaning in the discursive interaction of members of "natural communities". Conversation and discourse analysis look for order and regularity in human actions right where the interaction is taking place, observing the ways persons organize their encounters with others. Empirical methods help us understand how people regulate shared activities and how meanings are attributed to the artefacts with which they interact, including the technological ones (Schegloff, 1989).
The ethnographic and discursive perspective (Duranti, 1997; Ochs, 1999) is able to grasp the social complexity of the negotiation practices, considering as the unit of analysis the activity system of the community of practice (instead of single individuals). Communities use technology in their social and material contexts; they assign shared meanings to the tools used that are developed and defined through the continuous negotiation of their possible uses (and non-uses), benefits, disadvantages and peculiarities. This negotiation process explains how the use of each technology is shaped and developed by different communities of practice. Pre-existing shared practices act as essential mediators between the intended (by technical developers) meaning of technologies and their actual use in the daily practices of each specific community. The "community" as the central unit of analysis of cultural ergonomics research leads to considering human action as always built by exchanges between persons in social contexts of inter-subjectivity.

Moreover, an innovative use of ethno-technology can be foreseen by implementing discourse analysis as a tool for improving the usability of technological devices in a situated way. Perriault (1989) developed the concept of logic of usage ("logique de l'usage") in order to define the function that users assign to the technology. The logic of usage of end users can significantly differ from that assumed by the developers of the tool. Since multiple paths are possible in a hypermedia as well as on the Internet, designers, in order to produce an effective tool, must anticipate the dynamic control of the user by constructing a metaphor that is concise, self-evident, culturally shared, and easily recognisable (Carrada, 2001). Grossen and Prochon (1997) synthesize their findings by highlighting the following points:

- Human-computer interaction "is an interindividual relationship mediated by a technological tool consisting of an indirect dialogue between users and designers" (p. 283).
- This sort of "indirect dialogue" between users and developers is the result of an interpretive activity based on reciprocal assumptions about a tool's functions.
- The "indirect dialogue" is developed in a specific context, in an interactive space where the logic of the technical solutions planned and the users' skills meet. The logic of usage is then the result of a negotiation process between the users' requirements for the tool and the users' interpretation of potential uses.

In this perspective, virtual environments are additional resources for interaction at a distance (Carlini, 1998).
As mentioned before, ethno-methods allow the re-construction of an "emic" description of the meanings that users ascribe to the logic of usage of the tools. From this point of view, ethno methods are certainly useful to describe in an ecological way the context, as the participants are perceiving and defining it. Discourse analysis can then be conceived as a tool that shows directly the interactive behaviour of users and the co-construction of intersubjectivity as a space where the members of a community negotiate, in real time, the interpretation of collective usage of communication tools. Discourse analysis allows highlighting the real role played by the additional resources available within virtual environments.

Through discourse analysis, it can be observed how those additional resources (for instance the graphical dimension or the chat on-line) can be used in a strategic way, during the interaction at a distance. Giving the floor to users' voices is then a method that allows developers to look directly into a situated collective reasoning about tools.
The innovative value of using discourse analysis can be foreseen in the way collected data can be used to re-plan the tools in order to make them fit better to the logic of usage that the community collectively recognised as the most useful one.

7. Discussion

All in all, computer supported collaborative learning offers promising new ways to radically change education, especially when the three C's (collaboration, constructivism and community) are taken into account. Three main approaches are, in our view, essential:

- Immersing students in an active knowledge acquisition, giving them the chance to work in a situation which requires the construction of a product;
- amplifying the collaboration between the students inside the classrooms by giving tasks which stimulate group work and collective discussions;
- enabling collaborative distance learning and enabling students from schools to take part in wider communication networks.

It is, in our view, clear that these changes are not easy to reach. They involve so many changes of the educational system that great efforts will be needed to apply the new ways of thinking and the new possibilities in practice. To mention a few of the efforts needed: teacher training, innovation of curricula, institutional support.
Institutional factors were discussed extensively with teachers during the CL-Net project. The following were seen both by both teachers and researchers as the main factors affecting the potential of innovation:

- Organisational aspects often do not allow the establishment of innovative pedagogical practices (the management of time, space and

social boundaries for introducing new practice is often problematical).
- The space for innovation within the curricula is not always recognisable (especially when teachers have to deal with individual assessment while running cooperative projects).
- The participation of teachers in research activities, as it was done in the CI-net project, is not acknowledged within the social organisation of the school culture.

Research can play an important role in this when it is conceptualised in the new ways described above. These pedagogical, institutional and innovation aspects taken together lead to the following recommendations:

1) To support action research by researchers as well as by teachers on CSCL and to facilitate its dissemination.
2) To invest in teacher training for collaborative learning, knowledge building, and conceptual change.
3) To study how self-guided deep inquiry takes place and to understand how to guide it in the school environment.
4) To experiment with innovative curricula that introduces intellectually challenging topics appropriate for deep inquiry and conceptual change.
5) To provide the necessary institutional support for educational innovation; to educate school principals and other school authorities.
6) To facilitate the creation of communities of learners, teachers and parents who are interested in CSCL.

After the CL-net project was finished it became clear that the sustainability of innovation is still a different matter. When the conditions described above were met, important innovations occurred. Innovations stopped, however, after the researchers left the schools. The participation of schools in a research project does not involve any activity once a lack of research grants forces researchers to leave the schools. Schools and teachers are no longer supported, and the innovative practice introduced by the project cannot be continued or reproduced without any support. The solution for this problem, as we see it, is that schools participate in research projects from the beginning. Applications should be joint proposals of schools and research institutes. Furthermore, there should be a set of interrelated proposals, so that once the research is finished, teachers can continue to develop the project by, for example, scaling up the experience run in a pilot project to other classes, schools or disciplines or by consolidating best practices within their context of action.

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