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Analyzing Actual Uses of ICT in Formal Educational Contexts: A Socio-Cultural Approach

Análisis de los usos reales de las TIC en contextos educativos formales: una aproximación sociocultural

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Abstract

This paper has three goals: (1) to identify intended and actual uses of ICT in five different didactic sequences; (2) to compare the intended and actual uses of ICT in the sequences; (3) to investigate how the actual uses of ICT in the sequences transform and improve teaching and learning in those classrooms. The didactic sequences were studied using an observational, case study approach. Four main actual uses of ICT were identified. These actual uses differ from the intended uses. The identified actual uses did not involve so much transformation of classroom practice as it was intended. These results are discussed from a socio-cultural view. The need of analysing actual uses of ICT within the framework of teacher-students joint activity is stressed.

Key words: Educational technologies, information and communication technologies, educational innovation, teacher-student relationship.

Resumen

El artículo se propone tres objetivos: (1) identificar los usos previstos y reales de las TIC, desarrollados por los participantes en cinco secuencias didácticas diversas; (2) analizar el contraste entre usos previstos y usos reales; (3) indagar el grado en que los usos reales encontrados puedan considerarse transformadores de los procesos de enseñanza y aprendizaje. Se utiliza una metodología observacional de estudio de casos. El análisis ha permitido identificar cuatro tipos principales de usos reales de las TIC en las secuencias. Estos usos reales presentan diferencias con los usos previstos por los profesores, y son, habitualmente, menos transformadores de la práctica del aula que los usos previstos. Los resultados se discuten desde una perspectiva socio-cultural, remarcando la importancia de no separar el análisis de los usos reales de las TIC del análisis de la actividad conjunta profesor-alumnos en que esos usos se inscriben.

Palabras clave: Tecnología educativa, tecnologías de la información y la comunicación, innovación educativa, relación profesor-alumno.

Introduction

An interest in the study of the impact of information and communication technologies (ICT) on educational processes has brought about a growing inclusion of this technology at all levels of teaching. In this context, and in an effort to understand the impact, there has emerged an ever-increasing need for an empirical examination of the way in which teachers and students use ICT in the development of actual classroom practices (Squires and McDougall, 1997; E. Twining, 2002; Järvela and Häkkinen, 2002; Kennewell and Beauchamp, 2003; Tondeur, van Braak and Valcke, 2007). This approach involves shifting the emphasis from an interest in a direct exploration of the way ICT influences students' learning or performance, to the desire to study how ICT is included in educational practice and how, it may ultimately transform and improve them. This is assuming that students' learning is related to, and depends upon the quality of the classroom practices in which they participate.

Focus on the uses of ICT involves the need to identify the key dimensions of educational practices. Any analysis of these practices implicates a selection of experts consider their most important aspects. These are the theoretical frameworks and the models of the function of practice derived from those frameworks, those which can delimit and substantiate such a selection. In this case, these frameworks and models must not only account for the predicted learning goals, the previously-planned uses of ICT, and the final results obtained by the students. They must also account for the actual processes which produce these results, the ways in which ICT is in fact used by teachers and students throughout these processes, and to what extent their actual uses coincide—or not—with their predicted uses.

The authors of this work consider that an empirical approximation of the study of the educational uses of ICT can be beneficial for the adoption of a theoretical framework with which to conceptualize the educational practices inspired by the constructivism of sociocultural orientation. On the one hand, this is because there is in this framework an emphasis on the idea that ICT are tools or instruments mediating the constructive mental activity of students and of the teaching processes, which takes the natural form of the ability to ask the question, "What are the uses of these tools or instruments?" On the other hand, it is because this perspective proposes searching out and identifying these uses in a space composed of the joint teacher/student activity surrounding the activities, the tasks and the content which form the backbone of teaching/learning work in the classroom.

The consideration of the human mind as measurable by instruments is, as we know, one of the fundamental theses of the sociocultural perspective. According to Vygotsky and those who came after him, the upper-level psychological processes are characterized, precisely, by the use of socially-acquired instruments of cultural origin, particularly symbolic instruments such as language or other systems of representation. This use allows an active adaptation to the environment, as well as the awareness and conscious control which characterize these higher psychological processes. From this perspective, ICT is a novel means of representation and communication, the use of which may introduce significant changes in certain aspects of the psychological functioning of persons; a means which, if it does not constitute, in the strictest sense, a new semiotic system—since it primarily uses previously-existing semiotic systems, such as oral and written language, audiovisual images, graphic representations, etc.— creates, based on the integration of these systems, totally new conditions concerning treatment of, transmission of, access to, and use of information. It is in this sense that it has been proposed that we consider ICT as "cognitive tools" or mindtools (Jonassen and Carr, 1998; Jonassen 2006; Lajoie, 2000); that is, as instruments which permit people in general, and learners in particular, to *re-present* their knowledge in different ways, so as to reflect upon it, and appropriate it in the most significant manner.

These tools may be of very diverse types, and may mediate very diverse cognitive processes as well. Thus, ICT can act in many ways, from functioning as tools to support the semantic organization of information (databases, concept networks, etc.), to facilitating the comprehension of functional relationships (spreadsheets, microworlds, simulations, etc.) to making possible the interpretation of information (visualization tools, etc.), or interpersonal communication (e-mail, videoconferences, instant messaging, chat, etc.).

The use of these mediator tools, however, is not a use in which the participants (teachers and students) carry out the formal processes of teaching and learning in a strict or exclusively individual manner. On the contrary, it is a use located, necessarily, in the broadest framework of joint activity which some develop around the contents and tasks that constitute the object of teaching and learning (Edwards and Mercer, 1988; Coll, Colomina, Onrubia and Rochera, 1992; Tharp, Estrada, Stoll Dalton and Yamauchi, 2002). According to a well-established tradition in the sociocultural perspective, this approach is generally considered to be located at the core of the analysis of the psychological processes, and of the processes of teaching and learning in the classroom, particularly in joint activity.

Going beyond the contemplation of these three elements, this approach accentuates the relationships established between them: not only the learning (understood as the process of constructing meanings and of making sense of the contents), but also the teaching—the systematic, sustained help adjusted to this process of constructing meaning and making sense, These become possible, thanks to the joint activity—or to be more precise, to the sequences of joint activity in which teachers and students participate during periods of varying length, while developing activities and tasks centered on the content.

From this point of view, the essential difference between the multiple and diverse uses of ICT in school education does not lie so much in the characteristics of the technological resource used in each case, as it lies in the location of that difference in the conceptual framework defined by the interweaving of relationships among the three elements of the interactive triangle. While we must not overlook the particular characteristics of the various ICT tools under consideration, it is in the impact which the uses of these tools have on joint teacher/student activity that we find the key for analyzing their impact on educational practice, and thus, on the students' learning (Coll, 2004). Similarly, the incidence of these uses in joint activity constitutes the location in which the ability of ICT to transform and improve educational practices will be established or not.

In effect, certain uses of ICT can give place to forms of organizing relatively new forms of joint activity, or at least forms hardly possible without using ICT; forms, therefore, in which the ICT will be a real element of *value added*, and will have played an essentially transforming role. Other uses, however, are inserted into very similar forms of joint activity organization, essentially in those which are routine in classrooms having no ICT. In those cases, we see uses of ICT having few elements of added value, and little capacity for transforming practice.

Based on the theoretical approaches and ideas we have just pointed out in brief, the authors of this article propose a threefold objective: 1) to identify, describe, and analyze the uses of ICT developed by participants in five specific didactic sequences, chosen on the basis of relevant dimensions related to the use of ICT, and incorporating various technological resources at various levels and in different forms, 2) to analyze the contrast between the predicted uses and the actual uses of ICT in these five didactic sequences, and 3) investigate the extent to which the actual uses may be deemed transformational in teaching/learning processes. Reaching this triple objective can contribute to advancement in establishing a typology of ICT uses in formal educational contexts, which in turn can be useful for the purposes we have discussed: that is, a typology theoretically based on concepts and relevant and well-established principles, and empirically grounded in a sufficient pool of data drawn from the study of natural situations of teaching and learning with ICT accessible.

I. Method

In this work a case study methodology was used. This methodology included the in-depth analysis of five complete didactic sequences, selected with the aim of obtaining a "maximum variation" among them (Flick, 2004), taking a group of variables identified as relevant in the specialized literature: the greater and lesser emphasis on the activities and materials of autolearning, the relative weight of face-to-face interaction and non-presential situations, and the diversity and wealth of the incorporated technological resources.

In all these cases, the didactic sequences are developed in their respective natural contexts, without the researchers' intervention—except for the necessary data collection procedures—either in their design or in their development. In all these cases, as well, the process of observing and recording the sequences spanned their full duration, including the initial planning of the sequence by the teacher, and the final evaluation of the students' progress in the terms also established by the teacher.

1.1 The situations of observation

The first of the didactic sequences studied (DS1) is based on a course in the Catalan language for adult foreigners, based on an autolearning process with multimedia material. In this case, our intent was to analyze an instructional process strongly oriented toward autolearning, organized around very structured material, in principle self-sufficient and accessible through the use of ICT. The course contemplated practically no presential activities and would approach assignments and learning activities from an independent standpoint, without requiring or expecting systematic interaction either between the teacher and the students, or among the students themselves.

The second sequence studied (DS2) consists of the development of two themes of the class in the Psychology of Teaching, with students of the B.S. Program in Psychopedagogy of the *Open University of Catalonia* (UOC), a university which relies completely on distance learning, through its own Virtual Campus.

From the general design perspective of the research project, this sequence concerns an instructional process having almost no presential teaching/learning activities, but which is organized around work with telematically-accessible material, and the carrying out of teaching/learning assignments or activities which require—and consequently, predict—asychronic interactions of relative, periodic, systematic and planned frequency between the students and the teacher, using for these the appropriate informatic and telematic resources (e-mail, electronic message boards, forums, file storage etc.)

The third of the sequences studied (DS3) has to do with the development of a theme of a Contemporary History class in semi-presential format, supported by ICT, with students in the University of Barcelona's Bachelor's Degree presential Program in History. The theme included sessions in the ordinary classroom, and in the informatics classroom. In the latter, the students worked with hypertext and hypermedia materials on the theme contents, prepared by the teacher.

From the investigation's general design perspective, this sequence attempted to study an instructional process basically organized around the teaching and learning activities in presential modality, but which incorporated assignments and learning activities that would require the students to use informatic and thematic resources, as well as to access information structured as hypertext and hypermedia.

The fourth didactic sequence studied (DS4) concerns a guided research project, carried out by third-semester students of compulsory junior high school education (15 years old.) The project is called "Knowing the City of Barcelona," and is supposed to work with nearly all the areas of the course, combining work in the field and in the classroom. The students worked in small groups, and they had to make, as their final project, a web page summarizing what they had learned. From the project's general design perspective, this sequence concerns an organized instructional process regarding teaching/learning activities in presential modality, but whose development and execution, in some of its phases, require the use of informatic and telematic resources (in this case, searching for and consulting documentation and information on the Internet, the use of Ofimatic applications, and editing *web* pages.)

Finally, the fifth didactic sequence studied (DS5) concerns a collaborative telematic project developed by elementary-school students (12 years old) on meteorology. The students collected meteorological data, analyzed it, and telematically exchanged data and conclusions with students of other schools participating in the project. This sequence was an attempt to permit the analysis of an instructional process organized around teaching and learning activities in presential modality,

but whose development and execution required in some of its phases, the use of communicative and collaborative telematic resources (e-mail, electronic message board, forums.)

1.2 Data collection procedure

In the five sequences studied, the collected data were the following:

- Audio and video recordings of the presential class sessions.
- Electronic recording of the interactions between teacher and students, and between the students themselves, by means of ICT (forums, Email and other virtual communication and collaboration spaces.)
- Recording, by means of the program Camtasia, of a sample of the actions carried out by students and teachers using informatics programs (navigators, Ofimatic programs, hypertext and hypermedia materials, etc.).
- Interviews with the teachers and with a selected sample of students befor and after the sequence.
- Personal reports by teachers and students concerning their teaching and learning activities outside the classroom, presential or virtual, throughout the sequence.
- Materials and documents related with planning the sequence.
- Materials and documents used or produced by teachers and students during the sequence.

1.3 Data analysis procedure

For each one of the sequences, the data analysis followed five fundamental steps:

1. Identification of the instructional activities planned, and of the predicted uses of ICT in each of these. The planned instructional activities were established after interviews with the teachers, and using an analysis of the predicted uses of ICT in each. The predicted uses of the ICT were categorized using a deductive-inductive cyclical process as a basis, by which were defined, constructed and progressively refined the various typologies of use identified with the data, observing its sense from the concepts and theoretical ideas in the research base. Examples of the categories utilized, and of some of the identified predicted uses may be found in Coll (2004) and Coll, Mauri and Onrubia (2005). Starting with the results obtained in this phase, there were made, for the various sequences, graphic representations or maps of the "techno-pedagogic design" (Coll, 2004) of each one, and of the predicted uses of the ICT in each design.

2. Identification of the forms of organization of joint activity, or segments of interactivity, really developed by the participants throughout the DS. A segment of interactivity is defined as a fragment of joint activity characterized by a

recognizable pattern of interrelated acts, predicted and predictable, of the participants, which answers to a determined structure of social and academic participation. The operational criteria for the identification of the segments is based on the "model for the analysis of interactivity" of Coll and his collaborators (Coll *et al.* 1992; Colomina, Onrubia and Rochera, 2001). Examples of the types of segments identified can be found in Coll, Mauri and Onrubia (2005).

3. Beginning with the identification of the segments, graphic representations of the kinds of organization of joint activity and its evolution were made. These maps could have, in some sequences, successive levels of depth, which showed, for example, the ways of organizing the joint activity for the whole group class, for various small groups of students working simultaneously within the framework of the class group, and for pairs of students in the same small group who worked in parallel for a time. As well, the maps took into account the possible asynchronicity in the interactions between the participants i.e. in the virtual interactions in DS2 and in DS5), and the possible simultaneousness of various forms of organization during the same days as a virtual debate and a work and a task, also virtual, in small, collaborative groups.)

4. The identification of the actual uses of ICT by the participants in each of the kinds of joint activity organization—segments of interactivity. As in the case of the predicted uses of ICT, the typology of actual uses finally established was the result of a cyclical process of adjustment between theories and data, and of progressive refinement of the categories used. Examples of the categories used, and of some of the actual uses identified in various sequences can be found in Coll (2004) and Coll *et al.* (2005). The results obtained regarding the actual uses of ICT are included in the interactivity maps, permitting the creation of maps of actual ICT uses in the sequences analyzed.

5. Systematic contrast between the predicted uses and the actual uses of ICT identified for each DS, beginning with a comparison between the techno-pedagogical design, and the maps of interactivity and actual uses of ICT. This contrast permits the establishment, in each case, of predicted uses that did not carry over into practice, actual uses of ICT which had not been predicted, and differences of distribution and intensity between the predicted uses and the actual uses. As well, and starting with the maps' various depth levels, this permitted the identification of commonalities and differences in the use of ICT among various participants in the same DS, simultaneously, or at different times during the process.

II. Results

A detailed presentation of the analysis results for each of the five didactic sequences studied would make this article far too long. We therefore chose to use a synthesis of the general principles derived from an individual analysis of each

sequence, and which permits the establishment, from a general and panoramic point of view, the basic conclusions of this study. We will organize the exposition of these results in three nuclear parts, corresponding to the three concrete objectives for our work which we stated in the introduction: 1) a description of the principal, actual uses of ICT identified in the DS; 2) the relationship between the predicted uses and the actual uses of ICT; and 3) the more or less transformational character of the actual uses identified.

2.1 The actual uses of ICT in the didactic sequences analyzed

In the various didactic sequences analyzed, it has been possible to identify a relatively large number of types of actual uses for ICT, with varying levels of presence and intensity in each case (for some examples, see Coll, 2004; Coll *et al*., 2005). An overall analysis of this set of uses, however, permits grouping them into four large categories, which synthesize by and large the most habitual and extended forms of actual ICT use in the five sequences analyzed. They are as follows:

1. *Uses of ICT as an instrument of mediation between students and the learning content or task*. In this type of use, students use ICT to access teaching/learning content, explore it, use and understand it in a variety of ways and at various levels, or utilize it as a help in carrying out or resolving specific teaching/learning tasks and activities. For example, we include in this category the uses of ICT to look for and select information relevant to the content of teaching/learning; to access, examine and explore stored contents having more or less structure or internal organization, and having higher or lower levels of freedom; to access, examine and explore prepared images of teaching/learning content in a variety of formats and codes, from hypertext, multimedia and hypermedia presentations to simulations or other types of images; to access storage of more or less complex activities and tasks with higher or lower levels of interactivity (feedback, adjustment to the characteristics of the student, etc.); to develop a process of autonomous or nearly autonomous study beginning with materials for autolearning in digital format.

Also part of this category is the use of various programs of mindtools, in the definition of the term which we have taken from above: that is, as a tool which allows the student to become involved in some type of reflection and critical thinking about the content to be learned; expressing it in new and significant ways through the process of exploration in depth, analysis, reorganization, translation to different forms of imagery; searching for structures of meaning…In all these cases, and in terms of the interactive teacher/students/content triangle, this category basically locates ICT in the area of the relationship between the student and the content, leaving the teacher more or less off to the side. Because of this, and usually, it has to do with uses that are largely carried out in an individual manner, and in which, in many cases, the teacher's influence is indirect. This type of use, in the sequences studied, is the primary one for ICT in DS1; has a relevant weight in DS3 and DS5;, and is also important in the other two sequences.

2. *Uses of ICT as an instrument of representation and communication of meanings regarding the content or teaching and learning tasks for the teacher and/or students*. In this case, teachers or students use ICT basically as a support for presentation and communication to others (in the case of the teacher, to the students; in the case of the students, to the teacher, and to other students, or to audiences more or less external) of certain broader or more limited aspects of the contents and tasks with which they are involved. Thus, this type of ICT uses means supporting, helping or amplifying some of the teacher's activities or functions, such as presenting information through expositions and explanations; illustrating, establishing relationships between aspects or elements of the content; modeling a procedure, such as supporting, helping or amplifying some of the students' activities and work processes, for example, exchanging information and proposals, contributing to a discussion or intervening in the framework of an explanation by the teacher, presenting the results of products of an activity or assignment.

In terms of the interactive triangle, this is a type of use primarily affecting the relationship between teacher and content and/or between student and content, together with the relationship between teacher and student by means of the presentation and representation of the content. In the sequences studied, this type of use is primarily employed in DS4, and also appears in a relevant manner in DS2, DS3 and DS5.

3. *Use of ICT as an instrument for monitoring, regulating and control of the joint activity of the teacher and students with regard to the contents and tasks of teaching and learning*. The distinguishing element of this type of use is the link between the use of ICT and the regulation of the teaching/learning process and thus, between the use of ICT and evaluation—summative, but also, and especially formative and developmental—of this process. Therefore, in this case, ICT is used to help the teacher monitor, regulate and control the progress and difficulties of the students in doing tasks and in learning content; to help the students monitor, regulate and control their own learning processes; and to enable them to ask for and receive feedback, guidance and aid from the teacher in doing the tasks and in learning the content.

In terms of the interactive triangle, this type of ICT use affects the set of relationships between teacher, student and content, but is specifically concentrated on those ingredients of mutual monitoring and regulation implied in that relationship. In the sequences studied, this type of use occupies an especially relevant place in DS2.

4. *Uses of ICT as an instrument for configuring learning environments and work spaces for teachers and students.* In this type of use, ICT is employed to re-create or generate specific learning environments or work spaces, which essentially exist thanks to them, and which are not limited to reproducing, imitating or simulating preexisting environments which do not include the ICT. These can be individual or collaborative work spaces or learning environments; for a student, a small group, or a whole class group, and they can be public or private. In certain cases, they

can be spaces or environments that operate in parallel fashion or simultaneously—i.e. when multiple virtual spaces are generated for small group work, for the simultaneous use of different groups of students.

In this type of use, the interactive triangle in its set, is re-created through the ICT, for part of the teaching/learning process, or for the entire development of this, and the ICT define new and original possibilities and restrictions for the types of relationships which they can establish between its different elements. This type of re-creation can take place by means of virtual teaching/learning environments, but not all virtual environments adequately exemplify this type of use. This is by far the kind of ICT use that appears least in the sequences studied; it appears only to some extent in DS2 and DS5.

2.2 Actual uses and predicted uses of ICT in the didactic sequences analyzed

The basic result extracted from the systematic comparison of the predicted uses and the actual uses of ICT in the sequences analyzed is the existence, in practically all these, of relevant differences between some and others. These differences can take various forms: predicted uses of ICT which do not appear in the actual development of the sequences; unpredicted uses which do appear; uses expected to appear in a primary role, but which turn out to play a secondary part; uses expected to play a secondary part, but which in reality turn out to be those most used. In any case, it usually happens that what teachers and students actually do with ICT in the development of the didactic sequences deviates significantly from what the teachers had anticipated, and from their objective in including ICT in the sequences.

Concerning this, we should consider two issues. The first is that, in many cases, it does not simply have to do with divergences or habitual and predicted differences between a particular design for educational action, and that design as put into practice. From a sociocultural perspective, one assumes that the joint activity is always constructed in the interaction itself, and that consequently it is never a simple mechanical transposition of a previously-delineated plan; therefore, one assumes that always and necessarily there will be differences between the practice designed or planned, and the practice in actuality. In the sequences analyzed, however, these differences show a particularly remarkable intensity and relevance.

In addition, and this is the second issue to look at, the differences show, primarily, a tendency in the sense of which the actual uses of the ICT in the sequences are less transforming, and in which they exploit less the potential of the technological tools attached to what has been planned and attempted with their predicted uses. For example, therefore, in DS3, what is being attempted through the use of the ICT in promoting the ability to explore and deepen the autonomous and self-regulatory aspects of the content on the students' part, in practice turns out to be mostly a support for the teacher's explanation. As well, the uses of ICT expected to promote collaborative work and learning in DS2 and DS5, became in practice a merely communicative use, which does not imply an actual process of collaboration. A

final example is constituted by the web pages made by the DS4 students, who barely took advantage of the possibilities of the hypertext and hypermedia of the digital format, and who limited themselves to reproducing in an almost identical manner, the format of a traditional work done on paper.

In several cases, it becomes clear that these changes are not due to the lack of experience or knowledge on the part of the teacher, since in all the sequences, the teachers were persons having ample experience and competency in incorporating ICT into their classes, and in employing it in the ways used in the respective sequences.

2.3 Uses of ICT, and transformation and improvement of educational practice in the sequences analyzed

The most general result possible to extract from the analysis of the sequences considered is that, taken together, the majority of the actual uses of the ICT identified in these sequences have a limited effect on the transformation and improvement of the educational practices. The majority of actual uses of the ICT identified in the sequences do not appear to modify substantially the forms of organization of joint activity. Instead, they essentially reproduce and retain patterns of action very similar to those which can be found without the use of ICT.

III. Conclusions and discussion

Considered together, the results obtained in relation to each of the three specific objectives formulated for the study present some convergences worthy of mention. Thus, and in the first place, it is verified that of the different types of ICT uses identified in the sequences analyzed, the less habitual are those in which ICT serves as an instrument of configuration for learning environments and work spaces for teachers and students—this is to say, precisely those uses which do not limit themselves to reproducing, imitating or simulating teaching/learning environments possible without the presence of ICT, and which, by contrast, take more advantage of its specific potential and its added value. In fact, the actual uses of ICT in the sequences analyzed seem to demonstrate a limited effect in the transformation and improvement of educational practices, and do not substantially change the forms of organization developed during the joint activity.

At the same time, it is verified that the actual uses of ICT in the sequences exploit the potential of the technological tools less than the teachers expected or predicted. Therefore, they transform the practice less than the teachers thought they would, or hoped they would.

This overall pattern of results is interesting, and can be discussed from several points of view. On the one hand, the typology of uses identified presents some outstanding concurrences with typologies previously proposed by some authors who share a concern for studying and identifying the actual uses of ICT, while it also integrates and amplifies the proposals of those authors.

Therefore, and as we have pointed out, one of the underlying axes which permits the differentiation of the categories we have established, is that which is relative to whether the ICT are essentially used in the framework of the student/content relationship (or teacher/content)—as in the first two categories we have identified—or in the broader framework of the interactive triangle as a whole—as in the two last. We find the importance of this axis also in the results of Tondeur *et al.* (2007), in a study of the uses of ICT in elementary schools, with a sample of 352 teachers. These authors distinguish two principle types of educational uses for ICT in the sample (in addition to the use of ICT as content, or object of teaching and leaning in itself.) The first is called by the authors "computers as an information tool", and includes aspects such as the use of computers for information search or for making presentations. The second is called "computers as learning tools", and includes the use of various kinds of educational programs which permit research or practice. In the first type of uses, the distinctive element is precisely that the "*emphasis is on the interaction between pupils and the subject-domain content: researching and processing information and communication*" (Tondeur *et al.*, 2007, p. 204*)*. It is worthwhile to observe that this correlation is produced between studies which use very different methodologies—ours, of a qualitative and intensive type, based on case studies; and that of Tondeur *et al.*, of a quantitative and extensive character, using questionnaires.

In another sense, the important consequence which has an added value in the categorization of the uses we have identified, and specifically in the last of these; and the transforming character of those practices using ICT, concurs with some of the distinctions suggested by Twining (2002), in his proposal for a framework of analysis of actual computer uses in practice (Computer Practice Framework –CPF–). As part of this proposal, Twining distinguishes three ways of using ICT ("for support", "for extension" and "for transformation"), which are differentiated by the use of three criteria: whether the addition of the computer does or does not change the content which the students learn, whether it does or does not change the processes by which they learn, and whether or not the practice developed could or could not be carried out without the computer.

The difficulty which the inclusion of ICT with a transforming effect occasions for the teachers, as reflected by our results, has also been shown by numerous, previous studies (i.e. Pelgrum, 2001; Anderson, 2002). Representative of this, is one of the principal conclusions of a recent, ample study on the use of the Internet in the schools of Catalonia, done by IN3 of the *Open University of Catalonia* (2007). According to this study, teachers tend to use the Internet to maintain the patterns of traditional teaching, rather than to be more innovative. Several studies have also begun to reveal some of the conditions required for facilitating the use of ICT so as to give it greater transformational power. (i.e. Cuban, 2001; Zhao, Pugh, Sheldon and Byers, 2002).

All in all, the principal point of interest and discussion of our results is, as we see it, that which is pertinent to the study of joint activity in the classroom, and especially, to the forms of organization of joint activity between teacher and students—its

construction, development and evolution as a valuable gateway to the comprehension of the actual uses of ICT, and as an aid in the eventual design of teaching and learning processes in which these uses maximize the transformational possibilities and the value added by this type of technology.

The difference between "techno-pedagogical design" and actual or effective use of ICT, and the connection between the study of these uses and forms of organization of joint activity between teachers and students, have in fact and in our view, some theoretical and methodological advantages that open new and promising possibilities in the study of the assimilation of ICT in the teaching/learning processes.

In effect, and from a theoretical point of view, they permit an empirical analysis of their inclusion, without an artificial separation from the study and analysis of the educational practice in which their incorporation occurs, and in the context of a general model of that practice. The consideration of the interactive triangle, and the fundamental dimensions of the same, makes it possible to address in the study of the practice the integrated use of ICT and the particular practice in which they are included, or in other words, the instrument of mediation, and the activity mediated by that instrument. For us, this is more than enough to show that the above is one of the main difficulties or limitations of the usual approximations used to study the impact of ICT in formal educational processes.

In addition, the connection between the study of the use of ICT and the forms of organization of joint activity opens the door to a broader and holistic view of the elements that influence the way in which ICT is ultimately implemented in the classroom (Lim, 2002), since it permits a relationship between these forms of organizing joint activity, and the broader activity systems in which they are inserted and to which they are linked. In parallel, and from a methodological point of view, the distinction between "techno-pedagogical design" and the actual or effective use of ICT, and the connection between the study of these uses and forms of organizing joint activity between teachers and students, makes the study of the uses of ICT in the classroom available as a methodology for analysis of widely-contrasting educational practices. Furthermore, it ensures strict continuity between general theoretical options to be adopted, and specific methodological decisions to be made.

As Twining points out (2002, p. 104):

> It is clear that there is a significant mismatch between the aspirations one commonly hears for what ICT is going to do for education and what is achieved […] Thus, […] one needs to distinguish clearly between aspirations, intentions and what is achieved. For example, a teacher may identify the predominant objective underlying a particular activity as being to use the computer as a tool to enhance children's learning in English […], whilst an observer might note that the children spend all of their time learning how to operate the software […]. Similarly, a painting program may have the potential to transform the curriculum and a teacher might intend that children use it to create pictures using processes such as trial and

> error and exploring techniques not available without a computer […], when in practice the children simply replicate work that they have already done using "potato stamps", paints and paper without changing the content or processes that they engage in other than automating some aspects of it.

Focusing on the study of the forms of organization of joint activity is, in this context, in our view, and for the reasons mentioned, a theoretical and methodological tool of special interest to help us in making "…a clear distinction between aspirations, intentions and what is achieved." The results we have very briefly presented, seem to confirm this.

However, it is worthwhile to note that, in our view, this does not mean that this is the only level of analysis in the study of the impact of ICT in educational practices. As we have said, it is necessary, first, to expand the focus of investigation by taking into consideration all the systems of activity included in joint activity carried out by teachers and students in the classroom. We also need to address more specifically the particular intra-psychological processes that students employ when using ICT—especially in those uses which are more innovative and transformational, and which can help students put into focus what is developed in the classroom, as well as the learning ultimately achieved. In this regard, the analysis of the forms of organization of joint activity could, from a socio-cultural theoretical perspective, offer a relevant point of unification in the attempt to build a comprehensive and integrated approximation to the complex problem of including ICT in formal educational processes, their effects, their potential and their limitations.

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