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Situated uses of ICT and mediation of joint activity in a primary education instructional sequence[1]

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Abstract

Introduction. From a socioconstructivist and situated perspective of teaching and learning processes, the authors analyze how one teacher and her group of 19 sixth-grade pupils use ICT. The study focuses on the way these tools mediate their activity, and evaluates the tools' potential for teaching and learning innovation.

Method. A case study method was used to analyze the development of an instructional unit in natural sciences, where pupils worked in small groups. The sequence was divided into three phases, each comprising different sessions. A model for analyzing educational interaction was applied, based on: a) identification and characterization of the forms of joint activity, and b) a typology of uses of ICT oriented to how the student, the content and the teacher jointly interact.

Results. Different uses of ICT are identified as a function of the different phases of the instructional sequence and of the characteristics and challenges presented by the different tasks at each phase. Furthermore, results show that ICTs are primarily used to mediate between pupils and content and, to a lesser extent, between pupils, content, and the teacher.

Discussion and **Conclusion.** In conclusion, the capacity of ICTs to transform educational practice in the classroom depends on the situated use of these tools in authentic teaching and learning situations, and also on new educational possibilities that these tools present for mediating joint teacher-pupil activity.

Keywords: Educational uses of ICT, Joint activity, Authentic tasks, Educational influence, Primary education.

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Usos situados de las TIC y mediación de la actividad conjunta en una secuencia instruccional de educación primaria

Resumen

Introducción. Desde una perspectiva socioconstructivista y situada de los procesos de enseñanza y aprendizaje, en este trabajo se analizan los usos de las tecnologías de la información y la comunicación –TIC– que llevan a cabo una profesora y 19 alumnos de sexto de educación primaria. El estudio se centra en el papel mediador de las TIC en la interacción y en su potencial para innovar los procesos de enseñanza y aprendizaje en el aula.

Método. Utilizando una metodología de estudio de casos, se ha procedido a registrar y analizar una secuencia instruccional sobre la metodología científica en ciencias naturales en la que los alumnos trabajan en pequeños grupos. El análisis de los datos se ha realizado mediante un modelo de análisis de la interacción educativa que permite identificar las formas de organización de la actividad conjunta, y mediante una tipología de usos de las TIC que median en la interactividad.

Resultados. Los resultados muestran usos diversos de las TIC en función de las fases y momentos de la secuencia instruccional y de las características y exigencias que plantean las tareas en cada una de ellas. Asimismo, los resultados ponen de relieve que las TIC se utilizan prioritariamente para mediar las relaciones entre alumnos y contenido y, en menor medida, para mediar las relaciones entre profesora, alumnos y contenidos de aprendizaje.

Discusión y **Conclusión.** Se concluye que la capacidad de las TIC para transformar las prácticas educativas en el aula depende del uso situado que se hace de ellas en situaciones auténticas de enseñanza y aprendizaje y de las nuevas posibilidades educativas que introducen para mediar la actividad conjunta entre profesor y alumnos.

Palabras Clave: Usos educativos de las TIC. Actividad conjunta. Tareas auténticas. Influencia educativa. Educación primaria.

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Introduction

Recent decades have seen more widespread use of Information and Communication Technology (ICT) in the classroom in order to promote learning. Learning how computers work (hardware), how to use computerized programs (software), and using Internet to search for, represent and communicate information have been gradually incorporated into primary education, giving way to a broad variety of situations, everything from isolated uses of technology to the configuration of electronic learning environments. However, research to date shows that incorporating ICT into education in general, and into primary education in particular, has not brought about the expected improvement in pupils' learning, and that the use of these technologies is generally very limited (see, for example, Barquín, 2007; Cuban, 2001; Zhao & Frank, 2003).

Of the three basic uses of ICT identified by Muraro (2005) – that is, as an *object of learning*, referring to the use of technology as a domain of learning, incorporated as subject matter in a curriculum; ICT as an instrument *for learning*, referring to the use of technology as a resource for solving problems from other domains of the curriculum; and ICT as an instrument *for teaching*, referring to the use of technology as a didactic resource for the teacher – studies agree that in primary education, the first type is by far the most common.

Several factors explain this underutilization of ICT and the underexploitation of its possibilities for innovation and improvement in educational practice, for example: a lack of equipment in classrooms, the scarcity of educational software, little knowledge of the existing software, and above all, the still inadequate teacher preparation in educational uses of ICT (Colás & Jiménez, 2008). Some studies show that teachers tend to incorporate technology in situations where it does not require big changes to their prior teaching method where ICT was not being used (Zhao & Frank, 2003), and that the main obstacle to educational innovation supported by ICT often lies in the educators' teaching practices themselves (Sigalés, Mominó & Meneses, 2009).

On one hand, the organizational and structural characteristics of schools form an institutional framework that favors and encourages incorporation of ICT for certain educational uses. On the other hand, the way that teachers use ICT depends on the theoretical framework that they adopt and their beliefs about the educational utility of these technologies. In the first

aspect, space and time flexibility facilitates the appearance of innovative uses of technology, making it possible to diversify the contexts and timing in carrying out educational experiences (Fernández & Correa, 2009). Regarding the second aspect, some studies show that a teacher's constructivist perspective of teaching and learning processes is a predictor of ICT uses that the teachers themselves consider to be positive for learning (Becker, 2000; Blantoon, Moorman & Trathen, 1998; Tondeur, Van Braak & Valcke, 2007). And studies on teacher beliefs regarding ICT show that, despite giving them a high positive value for improving student participation and for working in groups, for stimulating student interest and for facilitating autonomous learning, teachers actually make little use of ICT in the classroom for these purposes (Aera, 2005; Instituto Nacional de Evaluación y Asesoramiento Educativo, Neturity y Fundación Germán Sánchez Ruipérez, 2007).

In short, in the light of results from previous studies, we approach the challenge of investigating the uses and contexts that make it possible to innovate and improve educational practices with the support of ICT, with the basic objectives of education in mind (learning for knowing, learning for doing and learning for being and for living with others), and in response to new demands from the information society (Coll & Rodríguez Illera, 2008; Marchesi & Díaz, 2009). One key aspect of this inquiry consists of analyzing whether the way that ICT is incorporated in the classroom really exploits the possibilities of these technologies for solving situations and problems relevant to students in today's society. This means directing our attention not only to effective uses of ICT but also to the level of authenticity, contextualization and relevance of such uses.

Within this framework, the present study has a two-fold objective. First, to describe and analyze the real uses of ICT by a teacher and her primary education students, in a face-to-face teaching and learning environment, while performing an activity that we may classify as authentic. Second, and closely tied to the former objective, this study seeks to provide certain criteria that can be used in characterizing the more or less transformational, innovative role of these ICT uses.

The educational use of ICT in the classroom from a socioconstructivist perspective

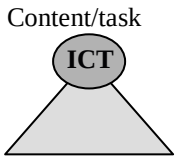
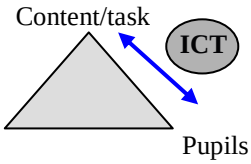
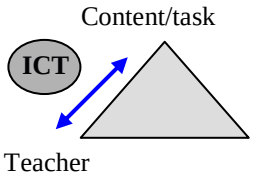
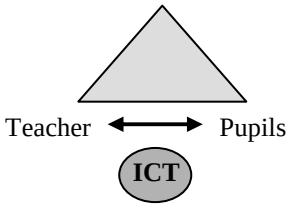
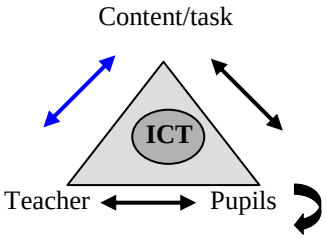
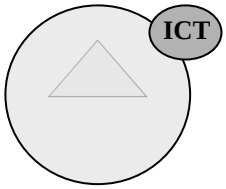
This study is based on a constructivist, communicative and cultural perspective of teaching and learning processes, postulating learning as a social, situated process (Palincsar,

1998; Wenger, 1988). From this perspective, we stress that students' learning takes place in the context of their joint activity with their teacher, revolving around school tasks and content, and that the teacher has a mediating role in guiding and orienting these processes (Coll, 2001). Incorporating ICT in the classroom with these constructivist postulates presents a double challenge: understanding how their use intervenes in the way that the joint teacher-pupil activity is organized over a given teaching-learning process, and studying how teachers help pupils and how they adjust their assistance over the course of this activity, thanks to the technologies (Coll, Mauri & Onrubia, 2008; Coll, Onrubia & Mauri, 2007).

The constructivist approach, with a social, cultural and situated orientation, emphasizes certain fundamental dimensions of the teaching and learning processes when these are studied from the perspective of authenticity. As much as possible, learning tasks which the joint activity is organized around should respect the same conditions and make similar demands on the students as do real situations using ICT. The purpose of these requirements is to stimulate complex intellectual challenges and learning which is highly meaningful. Furthermore, they should promote autonomous, situated use of the technology that helps pupils strategically use their knowledge of ICT as a function of the conditions, characteristics and demands of the context and of the task (Coll, Rochera & Onrubia, 2009; Darling-Hammond, Ancess & Falk, 1995; Díaz Barriga, 2005).

In order to study how ICT is used in teaching and learning environments and how it mediates the joint activity, we begin with a typology of uses, based conceptually on the constructivist perspective of sociocultural orientation (Coll, 2004). This categorization stems from the idea that the usefulness of ICT, in terms of its ability to transform educational practices in the classroom, does not depend as much on the intrinsic characteristics of the technology as on how it is used within the interactive triangle defined by three elements: pupils, teacher and learning content or task (Coll, Onrubia & Mauri, 2008). Table 1 summarizes the proposed typology of uses.

Table 1. *The mediating function of information and communication technologies (ICT) in relationships between elements of the interactive triangle (adapted from Coll, 2004; Coll, Mauri & Onrubia, 2008).*

Use of ICTs as ...	**Mediating function**	**Description and examples**
… an *object of learning*		Learning /teaching of content, how computers function, their utility and applications, characteristics of Internet usage, managing computer networks, etc.
… instruments that mediate the *relationship between pupils and learning content (and tasks)*		Searching for and selecting learning content; access to content repositories and/or learning tasks; carrying out learning tasks and activities
… instruments that mediate the *relationship between teacher and content*		Accessing respositories of learning objects and/or databases and banks of proposed activities; preparing and maintaining records of teaching and learning activities performed; planning and preparing activities
… instruments that mediate the *relations between teachers and pupils or between pupils*		Carrying out communication exchanges, not directly related to the content or tasks, between teacher and pupils or among the pupils (personal introductions, requesting personal or general information, greetings, expression of feelings, etc.)
… instruments that mediate the *joint activity realized by teacher and pupils* while carrying out teaching-learning tasks and activities		Enhancing certain teacher actions (explaining, illustrating, relating, etc. through the use of presentations, simulations, modelling, etc.); enhancing certain student actions (offering input, exchanging information and proposals, showing their progress and results); monitoring the students' progress and difficulties.
… instruments that form part of the *working or learning environment and platforms*		Configuring individual online learning environments or platforms (for example, materials designed for autonomous learning); configuring collaborative online work environments or platforms (for example, tools and environments for CSCL -- *Computer-Supported Collaborative Learning*); configuring concurrent environments or platforms for online activity.

As indicated above, this categorization allows us to appreciate the mediating role of ICT in joint activity, and to understand its educational potential. From this theoretical perspective, the place where educational assistance can be adjusted is in the framework of the interaction established between teacher and pupil while they are addressing the learning content and tasks. Thus, incorporating technologies in the classroom does not lead automatically or linearly to the transformation of teaching and learning processes. From this approach, the key is to identify how teachers and pupils make use of ICT as they carry out their activity in the classroom, and to analyze how using these technologies introduces changes in the organization of joint activity by mediating classroom relationships among pupils, teacher and learning content or tasks.

Method

Participants

The case under study is an instructional sequence in natural sciences, involving the participation of one teacher and 19 sixth-grade students (12-year-olds), who had already had previous shared work experiences on tasks and activities with similar characteristics. The teacher had ample teaching experience in the design and development of teaching/learning environments that incorporate ICT[2].

Instruments

Different instruments and procedures were used for collecting information on the instructional sequence: video, audio, narrative and electronic records, making up the main body of data. In addition, interviews were held with the teacher and a sample of the pupils, before and after the sequence, and we collected lesson planning documentation, and documents generated by the participants over the course of the instructional sequence.

Data analysis was performed using differentiated analysis instruments in order to identify the uses of ICT, and to identify the ways joint activity was organized when these uses were incorporated. For the *identification and analysis of ICT uses,* we used a typology of

[2] We wish to thank the teacher and pupils who participated in this study for their collaboration and willingness throughout the entire research process.

uses drawn from a constructivist perspective (Coll, 2004), built around the following categories: a) use of ICTs as learning content, b) use of ICTs as repositories of learning content, c) use of ICTs as tools in searching for and selecting learning content, d) use of ICTs as cognitive instruments at the participants' disposal, d) use of ICTs for aiding and enhancing the practice of teaching, and e) use of ICTs as tools for communication among the participants. For the *identification and analysis of the ways joint activity is organized* and how it evolves over the course of the instructional process, we used the interactivity analysis model (Coll, Colomina, Onrubia & Rochera, 1992; Coll, Onrubia & Mauri, 2008; Colomina, Onrubia & Rochera, 2001). The model makes it possible to identify different segments of interactivity – or ways that joint activity is organized – during each session of the instructional sequence. This identification is based on the participation structure that governs how participants act, that is, who can do or say what, with whom, how, when, for what outcome, and what use can be made of resources.

Procedure

Observation of the entire instructional sequence was carried out using a qualitative case analysis methodology (Stake, 1994; Yin, 2006). The sequence involved executing an educational project on climate and meteorology, the Edumet Project, over a total of 20 sessions held during the second and third trimesters of the school year. The sequence was organized around face-to-face teaching and learning activities that were intended to replicate the steps of scientific research: posing a certain question about climate and meteorology, collecting meteorological data, analyzing results and establishing conclusions. Activities were completed with the support of small group work and with the use of ICTs in the classroom. Additionally, electronic communication and collaboration resources were used (e-mail, forums) in order to share data and conclusions with different schools that participated in the project. The project was organized into three phases: (1) introduction to the project and to the participating schools, 6 sessions, (2) construction of a meteorological database, 6 sessions, and (3) data analysis and exchange of conclusions, 8 sessions.

During each of the phases, the teacher and pupils used different technology tools to prepare the required products. Thus, during the first phase, the teacher used the Edument Project website in order to explain the project, while students used a word processor for constructing a document to introduce their school. During the second phase, students used a

spreadsheet in order to construct a meteorological database. During the third phase, they used a drawing program to produce the final cover page for their research work, a word processor for writing up the research and a spreadsheet for preparing the graphs that accompanied their presentation of results. In addition, they used e-mail and the forum for exchanging information among the schools.

The data recording procedure consisted of video-recording the 20 sessions of the instructional sequence, along with audio and narrative recordings, with regular moderation from two researchers. In addition, online exchanges between the teacher and participants from the other schools were recorded electronically. Initial and final interviews were held with the teacher and with a sample of students (a small group of 5 pupils). Finally, we collected the documentation used for the planning and design of the instructional sequence, and the documents produced by the participants during the entire process.

Data analysis

The *identification and analysis of ICT uses* throughout the instructional sequence was carried out by applying the typology described above. At each phase of the project, the teacher's and students' predominant uses of ICT were identified, characterized and situated within the broader framework of the activity where they were being integrated. Finally, we specified the type of joint activity mediation that these ICT uses allowed.

The *identification and analysis of the ways joint activity is organized*, and how it evolved over the course of the instructional process, was carried out in line with the interactivity analysis model mentioned above. During each of the three project phases, this model was used to identify segments of joint activity according to the participants' predominant actions. Furthermore, since the situation involved face-to-face learning with support from ICTs, we specified descriptive information about all segments, whether executed with or without use of ICTs. Finally, the overall structure of joint activity is represented graphically using a map that contains all the segments with and without ICT that made up the entire instructional sequence.

Applying both types of analysis to the same body of data makes it possible to understand to what extent participants make effective use of the technology resources within the

framework of their joint activity. Interview content complements these analyses and was used to support interpretation of results as obtained from analyzing information about the execution of the teaching-learning sequence.

Results

Uses of ICT during the instructional sequence

The teacher and pupils exhibited several ICT uses during the three phases of the Edumet project, as identified and described in Table 2. The first column indicates the type of ICT use, the second column shows the percentage of this ICT use, and the third column gives a brief description. The last two columns situate the different uses within the framework of joint teacher-student activity, and identify the type of mediation involved.

Table 2. *Uses and mediation of ICT in the three phases of the instructional sequence*

Type of ICT use	**%**	**Description of the ICT use**	**Joint activity in which ICTs are integrated**	**Type of ICT mediation**
PHASE 1. Presentation of the Edumet project. Presentation of the participating schools. (% ICT use during this phase: 27.29%)				
ICT for defining the space/procedure for performing the task (*Teacher*)	1.08%	The teacher offers information about using the Edumet project webspace: communication and database	Teacher and students acting jointly in the context of introducing the Edumet project	Instruments mediating in the *joint activity produced by teachers and pupils* while carrying out teaching/ learning activities
ICT as an instrument for enhancing the activity of teaching (*Teacher*)	8.25%	The teacher explains the Edumet project		
ICT as learning content (*Teacher)*	2.41%	The teacher explains the windows structure and how to save a document without erasing a prior version		ICTs as the *object of learning*
ICT as a communication instrument (*Teacher*)	0.5%	The teacher publishes the school presentation and students' messages in the Edumet Website forum	Teacher and participants from other schools acting jointly	Instruments mediating in *teacher-pupil relations and relations among the pupils*
Teacher Total	11.84%			

ICT as a cognitive instrument (*Pupil-Pupil*)	83.86%	Pupils write up a text to introduce themselves (MS Word) and write messages in response to the other schools	Pupils (small group) acting jointly in the context of preparing meteorological data	Instruments mediating in the *relationship between pupils and learning content (or tasks)*
ICT with an instrumental use (*Pupil-Pupil*)	4.30%	Pupils format, save, copy and print documents		
Pupils Total	88.16%			

PHASE 2. Constructing a meteorological data base (% ICT use during this phase: 4.83%)				
ICT with an instrumental use (*Pupil-Pupil*)	100%	Students introduce paper-based data into the electronic database	Pupils acting jointly as a group in collecting data	Instruments mediating in the *relationship between pupils and learning content (or tasks)*
Pupils Total	100%			

PHASE 3. A research write-up using the database and an exchange of conclusions (% ICT use during this phase: 80.53%)				
ICT with an instrumental use (*Pupil-Pupil*)	76.60%	Pupils format, save, copy and print documents Pupils copy their introduction text from paper to computer	Pupils acting jointly in a small group in the context of data preparation	Instruments mediating in the *relationship between pupils and learning content (or tasks)*
ICT as a cognitive instrument (*Pupil-Pupil)*	14.11%	Pupils write messages to answer pupils from other schools and make an Excel graph with meteorological data		
Pupils Total	91.71%			
ICT as learning content (*Teacher)*	7.33%	The teacher explains the Print Artist program	Teacher and pupils acting jointly in the context of completing the project	ICTs as the *object of learning*
ICT as a communication instrument (*Teacher*)	0.96%	The teacher publishes the school's presentation on the Edumet website and their messages on the Edumet forum	Teacher and participants from other schools acting jointly	Communication exchanges not directed related to the content or tasks (personal introductions, requests for personal or gen. info., greetings, expressing feelings, etc.), between teachers and pupils or among pupils
Teacher Total	8.29%			

During *phase 1* (presentation of the Edumet project, presentation of schools), ICTs are used during 27.29% of the total time covered by that phase. Out of the total time that these technologies are in use, 11.84% corresponds to the teacher's use, and 88.16% to the pupils. The teacher uses ICTs as a support for presenting the information, as content for learning and in order to define the space and the procedure for carrying out the task. For their part, the pupils use technologies mainly as a cognitive instrument in order to draw up a text to introduce their school (MS Word) and to a lesser degree they make instrumental use of ICTs, in copying a paper document into the word processor. During *phase 2,* ICTs are used only 4.83% of the total time, and in all cases by the students: purely an instrumental use that consists of passing meteorological data from a paper template onto a Web-based template (100%). During *phase 3,* the percentage of ICT use if 80.53%. Of this total, 9.29% corresponds to the teacher and 90.71% to the pupils. The teacher uses ICT as a learning content, and to a lesser degree, in order to define the space and procedure for carrying out the task. The pupils, for their part, make a predominantly instrumental use of ICTs consisting of copying a previously handwritten document onto the computer.

Table 2 shows us that different types of ICT uses are connected with different ways of organizing joint activity, and these uses have different ways of mediating the relationships between the participants and between the participants and the learning content or task. Thus in *phase 1*, ICTs primarily intervene in the relationship between pupils and content (as demonstrated by the 83.86% use of ICT as a cognitive instrument), and to a lesser degree in the relationship between teacher, pupils and content (8.25% use of ICT in order to define the task and 1.08% as a support to the teaching activity). One can see that in this phase, ICTs have practically no involvement in communication among the participants (0.5%). In *phase 2*, ICTs intervene exclusively in relationships between pupils as they address the learning content or task (100% instrumental use). In *phase 3*, mediation is also primarily between pupils as they address the learning content or task (76.60% instrumental use and 14.11% cognitive use); to a lesser degree there is mediation in the relations between teacher, pupils and learning content or task (7.33%). Once again, ICTs are used minimally to mediate communication among the participants (0.96%).

Taken as a whole, these results show how ICTs are put to specific uses within the framework of joint activity organization and of the specific tasks that are being solved. Similarly, results show how these uses mediate the relationships between teacher, pupils and learn-

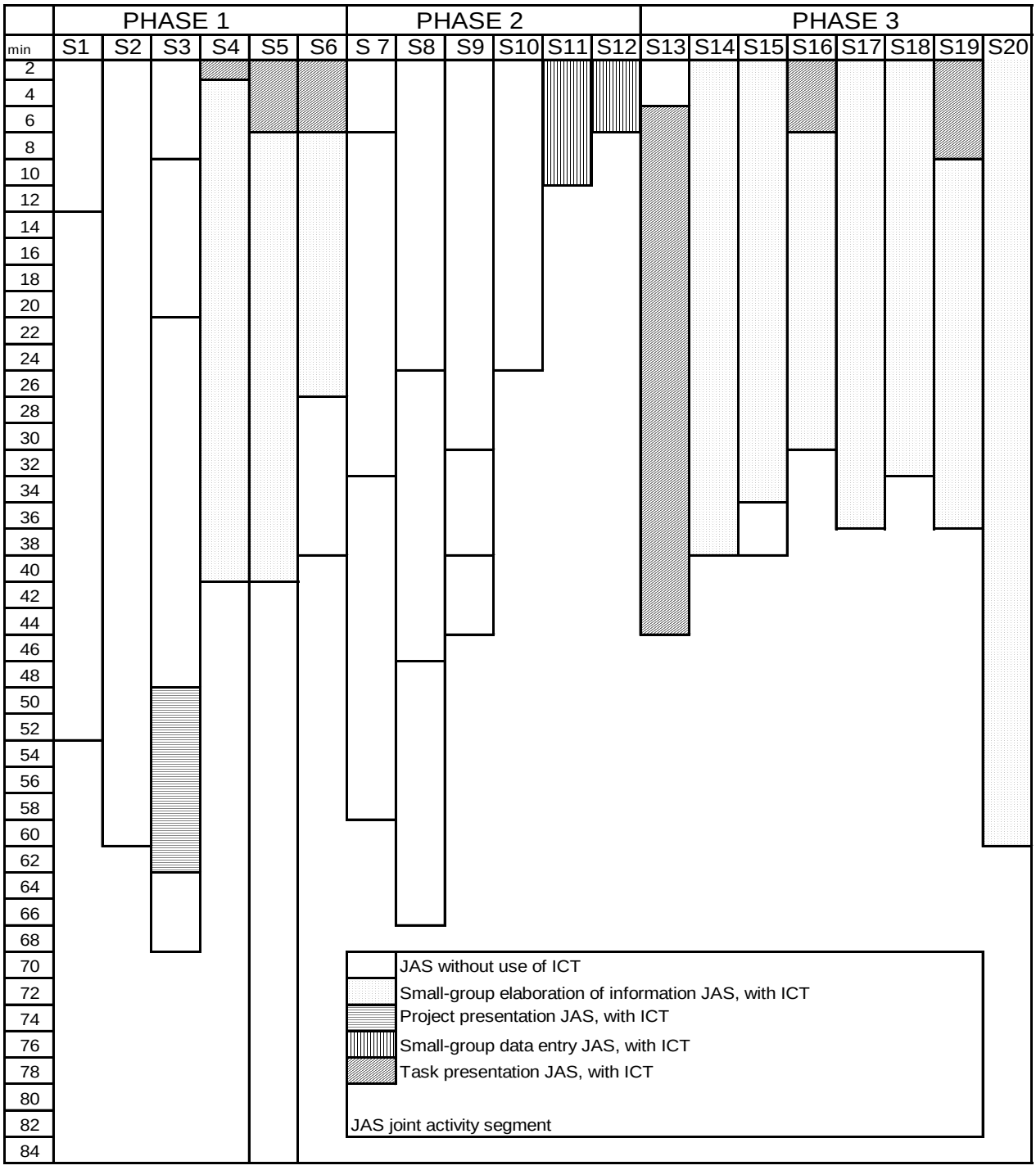
ing content during the instructional sequence. However, to have a global understanding of ICT uses within this face-to-face teaching-learning situation, we feel it is essential to step back and to place these types of uses within the context of the entire set of ways that the teacher and pupils go about organizing their joint activity, regardless of whether ICT use is involved.

Analysis of joint activity during the instructional sequence: Joint Activity Segments (JAS) with and without the use of ICTs

Applying the interactivity analysis model (Coll, Colomina, Onrubia & Rochera, 1992) to the recorded data allowed us to identify the overall structure of joint activity in each of the three phases of project (see Table 3). The general panorama of this structure shows how activities are combined, with or without ICT use, over the course of the instructional sequence. From a timing perspective, the structure shows that each phase was initiated without the use of ICTs, beginning with an orientation of the students' work in its different aspects, followed by a time when participants use technologies to solve different tasks that were part of executing the project.

The purpose of *Phase 1* is to construct an initial body of knowledge, shared among teacher and pupils, regarding the Edumet project and the participating schools, and to organize small working groups. The phase begins with a series of joint activity segments (JAS) that take place without the use of ICT: presenting the project to the entire class group (project presentation JAS), presentating the curriculum content (task presentation JAS, initial task execution JAS, and information transmission JAS), and organizing work groups (group organization and management JAS). Later on, JASs appear that include the use of ICT. These segments are related again to presenting the project via the Edumet website (project presentation JAS), presentation of the schools, where students work in groups to draw up an introductions text to be sent to the other schools (task presentation JAS and small-group elaboration of information JAS).

Table 3. *Global structure of joint activity: Joint Activity Segments with and without ICT, throughout the three phases of the instructional sequence*



Phase 3, for analyzing results, and drafting and communicating conclusions, was carried out almost entirely with the use of ICTs, with students organized for work in pairs. After an initial point when the teacher helps to organize the working groups, without using ICT

(organization and group management JAS), there are different joint activity segments using ICT, for presenting the research project script to the class group (task presentation JAS) and for drafting it in small groups (small-group elaboration of information JAS). In order to interpret these data, it must be kept in mind that the objective of the Phase was to draft a research report from the meteorological data contained in the database constructed previously. Students used ICT whenever they needed to as a function of the task requirements: for example, in order to produce a printed text, to make tables or to design the cover page.

Overall, ICT uses which appeared during the instructional sequence are linked to the needs and requirements of the learning process within an environment that simulates the phases of scientific methodology, as represented in the Edumet project. Therefore, these ICT uses are contextualized in authentic tasks, bringing students in touch with real uses of measuring and analyzing meteorological data in a situation that resembles scientific research. Furthermore, these uses appear to mediate the different ways that participants go about organizing their joint activity. Uses of ICT evolve as the project unfolds, offering the students new possibilities for learning: specifically, there are ICT uses *for teaching ICT, for teaching subject matter* linked to carrying out a climate and meteorology study, *for learning this content* within the context of small work groups, and *for communicating* with other schools.

Discussion and Conclusions

Based on the results described, it is possible to identify certain keys to understanding how the teacher and students made educational uses of ICT in the present instructional sequence, how the technologies and the teacher both mediate the teaching-learning process, and what possibilities these technologies may offer us when used in a contextualized manner for improving and eventually transforming educational practices.

The results of our study show that these particular ICT uses fit into the framework of different ways that participants go about organizing their joint activity. In this way, they create specific possibilities for and limitations to the participants' performance, and particularly to how the teacher can help her students by mediating, orienting and guiding the processes of building knowledge. These uses indicate the different channels where ICT may potentially mediate in instructional processes. First, ICTs are used *to mediate relationships between the students and the learning content*: this is the case of students using ICTs as cog-

nitive tools or as technological instruments. Second, ICTs are used *to mediate the relationship between teacher, pupils anc content*: this is the case of using ICTs to define the space and procedure for carrying out the task, or when used by the teacher to present content. Third, ICTs are used *as an object of learning,* such as when the teacher addresses the technology itself: how to save documents, create graphs and drawings, etc. In short, the technological characteristics of ICTs intervene in the characteristics of the task to be performed, and therefore, it is important that students have technological mastery of the instrument that will allow them to correctly perform the task. For this reason the teacher makes a point of including the teaching and learning of aspects she considers important for this purpose. Finally, although less predominant in the present study, other uses of ICTs that we identified point to its potential *for mediating interactions and communicative exchanges among the participants,* as is the case of using ICTs to share information with other participants from different schools.

Regarding the potential of ICT for improving and transforming educational practices, our results confirm those obtained in other recent studies (for example, Sigalés, Mominó & Meneses, 2009). In particular, they underscore that incorporating technologies in itself does not guarantee innovation, and that not all uses involve mediation or a meaningful change in the interactions formed between teacher and students, and with the content that is being taught and learned. In fact, a large majority of the real ICT uses that were identified in the instructional sequence can scarcely be termed "transformational", in terms of uses that promote the establishment of novel ways of organizing joint activity, ways that would not be possible without the technological resources that were present in the situation – for example the use of ICTs for asynchronous communication through the Edumet website. Results from our study also corroborate those of other previous studies (Barquin, 2007; Zhao & Frank, 2003) that relate to the underutilization of ICT potentialities for transforming the participants' joint activity into truly instructional activities: despite the potentialities of the techno-pedagogical design of the Edumet website for configuring an online collaborative learning environment, the teacher and pupils made little real use of this environment.

The transformational, innovative effect of technologies on the situation under study is more closely related to the contextualized, authentic use of ICTs at each Phase and moment of the Edumet project. This interpretation is reinforced by the teacher interview where she indicates that the project objective basically is for students to learn the criteria for using technological tools in the process of performing scientific research:

> *"Projects like this (Edumet) that (take) three or four months ... allow me to work on using certain tools, certain programs ... and the pupils ought to have criteria for using technology ... With the Edumet research, for example when they organize the data table, they ought to see what the columns are that they need, what the rows are, or see ... what type of graph would be most representative of what they want to present ... the technology should address the needs. In addition, in Primary they are supposed to learn the tool and learn it correctly, but for low-level implementations. In other words, if we use Excel, we use the minimum, such as how to make a graph, how to place a title … have them start learning criteria for using tools"*

How ICTs are used in the end, and how they mediate the ways that joint activity is organized, in one direction or another, seems to depend on the overriding intentionality of the instructional sequence and on the pedagogical options that underlie the instructional design – not only on the intrinsic characteristics of the ICTs. Pedagogical purposes of exposing students to currently accepted scientific perspectives and to using pair work as a suitable way of learning science are two options that are considered fundamental for building comprehension in natural sciences in primary education (Thurston, Grant & Topping, 2006; Thurston *et al.*, 2007). The opinions expressed by the teacher in the final interview support the interpretation that instructional design decisions are important for the teaching and learning of science:

> *"Technology in itself doesn't change anything … I can have computers here and still work in a classical, lecture style format ... you can work cooperatively and not use ICTs … just as I have them discuss things in front of the computer, they could discuss them in front of a poster board … if I present an issue that they must solve as a group, the presentation is exactly the same ..."*

Regarding the teacher's role as mediator, results suggest two large areas where teacher intervention is decisive for realizing the potential of ICT in transforming and improving educational practices. One on hand is the area of *planning and preparing the techno-pedagogical design* (Coll, Mauri & Onrubia, 2008) of the instructional sequence. The teacher makes decisions about the most appropriate activities for carrying out the Edumet project, the methodology to be used, the ways that joint activity is expected to be organized, and especially, how ICTs will be used to achieve project objectives, such as drafting texts, building a database, explaining content and tasks, communicating with other schools, etc. On the other hand is the area of *instructional or pedagogical implementation*, the teacher provides different supports and aids to the students' learning process – with and without ICTs – as a function of the needs that arise at each moment. This observation brings us to the recommendation expressed by

Hermans, Tondeur, Van Braak and Valcke (2008), that teachers develop multiple competencies in association with the educational use of ICTs for the achievement of educational objectives, based on a constructivist understanding of the teaching and learning processes that include teacher mediation.

In closing, with a view to further progress in the potential of ICTs for transforming educational settings and for optimizing students' learning, we acknowledge that this study presents certain limitations and also offers certain channels to further our understanding of factors and dimensions that intervene in improving learning processes with the aid of technology. One on hand, the qualitative nature of this study and its treatment of a single case mean obvious limitations to any generalization of conclusions; new studies and broader, more extensive approaches will help overcome this limitation. Similarly, speaking only of the study's limitations, there is a need to study instructional sequences from other stages of education, with other types of content and tasks and where other uses of ICTs are given priority, so that we may move forward in understanding their potential for innovating and improving educational practices.

On the other hand, even though a central feature of our approach has been to focus on analysis of real uses of ICTs in the framework of the participants' joint activity, there are other levels and dimensions of analysis that must be kept in mind in order to attain an overall view and understanding of the impact of technologies on learning processes. Thus, in order to understand some of the determining factors in constructing classroom teaching-learning processes, it is undoubtedly necessary to look at the institution, with a more macro perspective than the present analysis. According to authors like Fernández and Correa (2008), and as seen in the results of our study, time and space flexibility, and other curriculum alternatives, are factors that can significantly facilitate or hinder certain uses of ICTs. Similarly, a more micro perspective, focused on characteristics of the participants' performance and the content of their communicative exchanges, would be fundamental for understanding intra-psychological processes that are involved in how student learn during activities mediated by ICTs.

References

Area, M. (2005). Tecnologías de la información y la comunicación en el sistema escolar. Una revisión de las líneas de investigación. [Information and communication technologies in the school system. A review of research trends.] *Revista Electrónica de Investigación y Evaluación Educativa, 11*(1), 3-25.

Barquin J. (2007). Transiciones en la función docente. La transformación de la práctica educativa por la presencia de los medios electrónicos en la educación. [Transitions in the role of teacher. Transformation of educational practice due to the presence of electronic media in education.] *Revista de Educación, 344,* 497-509.

Becker, J.H. (2000). *Findings from the teaching, learning and computing survey: Is Larry Cuban right?* Paper presented at the School Technology Leadership Conference of the Council of Chief State School Officers, Washington, DC.

Blantoon, W.E., Moorman, G., & Trathen, W. (1998). Telecommunications and teacher education: a social constructivist review. *Review of Research in Education, 23*, 235-275.

Colás, P. & Jiménez, R. (2008). Evaluación del impacto de la formación (online) en TIC en el profesorado. Una perspectiva sociocultural. [Evaluation of the impact of (online) training in ICT for teachers.] *Revista de Educación, 346,* 187-215.

Coll, C. (2001). Constructivismo y educación: la concepción constructivista de la enseñanza y del aprendizaje. [Constructivism and education: the constructivist conception of teaching and learning.] In C. Coll, J. Palacios, & A. Marchesi. *Desarrollo psicológico y educación. 2. Psicología de la educación escolar*, (pp. 157-188). Madrid: Alianza.

Coll, C. (2004). Psicología de la Educación y prácticas educativas mediadas por las tecnologías de la información y la comunicación: una mirada constructivista. [Educational Psychology and educational practices mediated by information and communicatin technologies: a constructivist perspective.] *Sinéctica, 25*, 1-24.

Coll, C., Colomina, R., Onrubia, J. & Rochera M.J. (1992). Actividad conjunta y habla: una aproximación al estudio de los mecanismos de influencia. [Joint activity and talk: an approach to the study of influence mechanisms.] *Infancia y Aprendizaje, 59-60,* 189-232.

Coll, C., Onrubia, J. & Mauri, T. (2007). Tecnología y prácticas pedagógicas: las TIC como instrumentos de mediación de la actividad conjunta de profesores y estudiantes. [Technology and pedagogical practices: ICTs as instruments for mediating joint activity between teachers and students.] *Anuario de Psicología*, *38*(3), 377-400.

Coll, C., Mauri, T. & Onrubia, J. (2008). La utilización de las tecnologías de la información y la comunicación en la educación: Del diseño tecno-pedagógico a las prácticas de uso. [Use of informacion and communication technologies in education: From techno-pedagogical design to practices in use.] In C. Coll & C. Monereo (Eds.). *Psicología de la educación virtual. Enseñar y aprender con las tecnologías de la información y la comunicación* (pp. 74-103). Barcelona: Ediciones Morata.

Coll, C., Onrubia, J. & Mauri, T. (2008). Ayudar a aprender en contextos educativos. El ejercicio de la influencia educativa y el análisis de la enseñanza. [Helping to learn in educational contexts. Exercising educational influence and the analysis of teaching.] *Revista de Educación, 346,* 33-70.

Coll, C., Rochera, M. J. & Onrubia, J. (2009). De la evaluación continuada hacia la autorregulación del aprendizaje. Algunos criterios y propuestas en la enseñanza superior. [From continous assessment to self-regulated learning. Some criteria and proposals for higher education.] In M. Castelló (Coord.). *Tendencias actuales de la investigación sobre evaluación auténtica en secundaria y universidad* (pp.117-143). Barcelona: Edebé.

Colomina, R., Onrubia, J. & Rochera, M.J. (2001). Interactividad, mecanismos de influencia educativa y construcción del conocimiento en el aula. [Interactivity, mechanisms of educational influence and building knowledge in the classroom.] In C. Coll, J. Palacios, & A. Marchesi (Comps.). *Desarrollo psicológico y educación 2. Psicología de la educación* (pp. 437-458). Madrid: Alianza.

Darling-Hammond, L., Ancess, J. & Falk, B. (1995). *Authentic assessment in action: Studies of schools and students at work.* National Center for restructuring education, schools, and teaching, Teachers College, Columbia University: New York.

Díaz Barriga, F. (2005). *Enseñanza situada: vínculo entre la escuela y la vida*. [Situated teaching: connecting school with life.] Mexico: McGraw-Hill.

Fernández, E. & Correa, J.M. (2008). Integración de las TIC en proyectos colaborativos mediante apadrinamientos digitales. [Integrating ICTs in collaboration projects through online sponsorships.] *Revista Latinoamericana de Tecnología Educativa, 7* (2), 57-67. [http://campusvirtual.unex.es/cala/editio/]

Hermans R., Tondeur, J., Van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education, 51*(4),1499-1509.

Instituto Nacional De Evaluación y Asesoramiento Educativo, Neturity y Fundación Germán Sánchez Ruipérez (2007). *Las tecnologías de la información y de la comunicación en*

la educación. Informe sobre la implantación y el uso de las TIC en los centros docentes de educación primaria y secundaria (curso 2005-2006). [Information and communication technologies in education. A report on the introduction and use of ICTs in primary and secondary schools (year 2005-2006).] Madrid. Accessed March 30th, 2008 at: http://www.oei.es/tic/TICCD.pdf

Marchesi, A. & Díaz, T. (2009). Desafíos de las TIC. El cambio educativo en Iberoamérica. [Challenges of ICTs. Educational change in Latin America.] *TELOS. Cuadernos de Comunicación e Innovación, January-March, 78.* Accessed (13.02.2009) at: http://www.campusred.net/telos/articulocuaderno.asp?idarticulo=6yrev=78#n6

Muraro, S. (2005). *Una introducción a la informática en la escuela*. [An introduction to computer use at school.] Buenos Aires. Fondo de Cultura Económica de Argentina.

Sigalés, C., Mominó, J.M. & Meneses, J. (2009). TIC e innovación en la educación escolar española. Estado y perspectivas. [ICT and innovation in Spanish scholastics. Current state and prospects.] *TELOS. Cuadernos de Comunicación e Innovación, January-March, 2009, 78.* Accessed (13.02.2009) at: http://www.campusred.net/telos/articulocuaderno.asp?idarticulo=4yrev=78

Schrire, S. (2006). Knowledge building as asynchronous discussion groups: Going beyond quantitative analysis. *Computers and Education 46*, 49–70.

Stake, R.E. (1994). Case Studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of Qualitative Research* (pp. 236-247). Thousand Oaks (Cal.): Sage.

Tondeur, J., Van Braak, J. & Valcke, M. (2007). Towards a typology of computer use in primary education. *Journal of Computer Assisted Learning*, *23*, 197-206.

Thurston, A., Grant, G. & Topping, K. J. (2006). Constructing Understanding in Primary Sciences. *Electronic Journal of Research in Educational Psychology, 8*(4), 1-34.

Thurston, A., Van de Keere, K., Topping, K., Kosack, W., Gatt, S., Marchal, J., Mestdagh, N., Schmeinck, D., Sidor, W. & Donnert, K. (2007). Peer learning in primary school science: Theoretical perspectives and implications for classroom practice. *Electronic Journal of Research in Educational Psychology, 13, 5*(3), 477-496.

Twining, P. (2002). Conceptualising computer use in education: introducing the Computer Practice Framework (CPF*). British Educational Research Journal, 28*(1), 95-110.

Yin, R.K. (2002). Case Study Methods. In J.L. Green, G. Camilli & P.B. Elmore (Eds.), *Handbook of Complementary Methods in Education Research* (pp. 111-122). Mahwah, NJ: L.Erlbaum.

Zhao, Y. & Frank, K.A. (2003). Factors Affecting Technology Uses in Schools: An Ecological Perspective. *American Educational Research Journal*, *40*(4), 807-840.

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