

Information and Communication Technologies in Class Practice: A Case Study of Secondary Physical Sciences Teachers

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ABSTRACT

This paper seeks to explore the new roles that some French teachers of physical sciences are developing through the use of information and communications technology (ICT). Based on a content analysis of e-mails from a French ministry of education physical sciences mailing list and follow-up qualitative interview data with twelve teachers, it identifies and examines the perceived new roles of teachers alongside their use and appropriation of new technologies. The paper develops the argument that the introduction of ICT changes the role of physics teachers, with scientific knowledge no longer solely on the teacher's side but now shared between different sources.

Introduction

It is widely acknowledged that teachers need to change in contemporary education, with one of the main drivers of this change being information and communications technology (ICT). Via ICT new possibilities for teaching and learning are introduced and new learning environments emerge offering the flexibility to achieve goals of lifelong learning. ICT is not only bringing changes to the world we live in, but is also transforming the way we can learn, opening a new gateway to information as well as providing a new potential for interaction and dialogue. Although we do not yet know enough about how to manage the new tools of ICT for educational purposes, it is possible to derive pointers from today's experience of teaching and learning in order to help teachers in all types and levels of education to use ICT effectively. If nothing else we can be sure that, in the coming age of virtual education, teachers will

remain critical to quality of learning. My present research focuses on French physics teachers in secondary school and considers the impact of ICT on pedagogical practice. The purpose of the research is to provide information on the nature of changes taking place in teaching as well as the new roles of physics teachers brought about by the use of ICT.

Although a few French secondary physics teachers have experience of the Internet or of using it for teaching (Kalogiannakis and Caillot, 2001), the traditional organization of the French secondary school sometimes creates practical difficulties in using new technologies in class. However, there is currently great debate in the French educational system about how teachers should adapt their current teaching skills in the face of recommended new educational forms such as the 'Travaux Personnels Encadrés' (personal guided projects). The Travaux Personnels Encadrés (TPEs) are a new institutional form of learning and were introduced in all French secondary schools in the eleventh grade during the first quarter of 2000–1 and the year after in the twelfth grade. In this new form of learning, students work in small groups, choose a topic, conduct documentary research and then write a report that will be presented publicly. It is seen as being very important for students to use ICT as a tool of research for their TPEs. In order to guide students, teachers are also expected to develop new roles and new skills in ICT and in its use in the classroom.

ICT is often associated with changes in both learning activities and learning objectives for students and this has an inevitable impact on the role that the teacher is asked to play. However, with ICT new teaching strategies have emerged and teachers themselves need the opportunity to develop new classroom skills, new relations and new models of teaching (Baron and Bruillard, 1996). For example, e-mail enables professional communities to interact freely and increases the efficiency of communication between teachers. E-mail-based mailing lists can be used as collaborative work tools for interaction and dialogue. In this spirit, the French ministry of education created an electronic mailing list called PHYSCHIM (<http://listes.educnet.education.fr/wws/info/physchim>) in November 1999. The PHYSCHIM list is moderated, meaning that the messages are first sent to a moderator for approval before being available to all list members. The PHYSCHIM list covers all the French physics teachers in secondary schools and the public archives of the list are available either by topic or in chronological order. According to the supporting documentation, the purpose of this list is to foster exchanges between teachers in relation to: (i) their ICT use and more particularly their Internet use in class practice; (ii) emerging innovative educational practices and didactic reflection.

The use of e-mail lists in education

The Internet is a network of networks, and teaching strategies and resources can be shared through communication with other educators and may be integrated across the curriculum. Since 1994 the French Internet development policy in the field of education has deliberately been aimed at encouraging all the members of the school institution to communicate via new tools such as mailing lists, academic or personal web sites. These networks can be characterized as pedagogical networks (Drot-Delange, 2001), playing a vital role in the diffusion of innovation and new practices in class. Shank (1993) argues that Net communication is neither oral nor written, but it is semiotic and that the Internet is, in essence, a text-producing machine. He proposes the term multilogue for this computer-mediated form of interaction. Shank suggests that the most effective and unique forms of scholarly Net communication emerge where the multilogue is used for fostering shared understandings of circumstances and phenomena. Rogoff (1994) also argues that mailing lists may serve as zones of development for communities of teachers and learners and as places where all participants may learn.

In this study I propose the PHYSCHIM list as a virtual community in the sense of Rheingold (1993), with a potential for learning and development. The PHYSCHIM list archives are also a rich source of the exchanges between French physics teachers and they are good examples of how PHYSCHIM contributors, each from their own perspective, may contribute as well as benefit from others' contributions. It is also possible to consider the community of practitioners of this list as a community of learners in the sense of Rogoff (1994). In principle everybody, no matter how long they have been subscribers to the list, may have something to contribute and something to gain from participating. On the other hand, Lewenstein (1995) argues that, in spite of the great expectations for computer-mediated communication (CMC) as a medium for the advancement of scientific knowledge, such channels tend not to be actually used in this way. His results point rather towards an educational, autodidactic function of electronic discussions for 'qualified amateurs'.

Generally speaking, a scholarly mailing list offers a new and attractive way for a semiotic interfacing between education actors in a virtual environment (Rojo and Ragsdale, 1997). Faced with the introduction of the TPEs, it is very important that French physics teachers should be able to update their knowledge, to guide their students and to develop new roles. In order to put these new roles into context, this paper now offers a case study of an actual

ICT-based learning environment in the form of the PHYSCHIM list and examines the extent to which this list is perceived as a valued platform for continuing professional education by teachers who are facing ICT-based changes in their day-to-day practice. In this research, the PHYSCHIM mailing list is considered as a communication tool *and* as a learning environment for physics teachers.

Research methods

This paper now presents a content analysis of e-mails exchanged in the PHYSCHIM mailing list alongside the results from follow-up semi-structured interviews with twelve secondary school physics teachers. The discussion in the PHYSCHIM list has been analysed for a period of twenty-six months using the available archives reaching back to November 1999. In terms of the number of messages from the initiation of the list in November 1999 to December 2001, 3,023 messages were posted by the 650 subscribers to the list. Table 1 shows the total number of e-mails that French physics teachers have exchanged per month and per year over these twenty-six months. Of these 3,023 messages, the 227 messages concerned with ICT and TPEs were selected and analysed by a content analysis. In Table 2, we indicate the number of the exchanged e-mails by physics teachers concerning ICT and TPEs over the last twenty-six months. It is hoped that these messages can provide important information about the roles of teachers, as using ICT effectively requires a radical transformation of practice in classroom.

In terms of identifying the characteristics of contributors to the PHYSCHIM list, most of the time the end of a message to the list is demarcated by a sign-off presenting name and professional affiliation of the sender. There is considerable variation in the actual methods of complying, from simply signing a message on a first-name basis to elaborate automated signature files containing contact information concerning a visiting address, paper-mail address, telephone and fax numbers. For our research we did not select messages which were lacking a signature part.

The follow-up interviews were carried out with twelve physics teachers who were identified as contributors to the PHYSCHIM list. This sample came from secondary schools located in Paris and as such cannot be considered to be representative of all French physics teachers. The twelve interviewees were physics teachers who had long experience of innovation and had used new technologies in their classrooms. Having considered the content of messages

Table 1
Traffic in the PHYSCHIM list

Month	1999	2000	2001
January	–	81	115
February	–	72	96
March	–	108	260
April	–	102	75
May	–	115	196
June	–	135	175
July	–	49	33
August	–	57	26
September	–	132	192
October	–	135	163
November	22	188	190
December	24	124	158
Total of e-mails per year	46	1298	1679

Note: Data are number of all the exchanged e-mails per month and per year by French teachers of all kind of disciplines.

Table 2
Traffic in the PHYSCHIM list concerning ICT and/or TPEs

Month	1999	2000	2001
January	–	8	1
February	–	1	0
March	–	11	5
April	–	6	3
May	–	8	9
June	–	8	32
July	–	2	1
August	–	2	0
September	–	5	33
October	–	1	21
November	4	1	19
December	0	4	42
Total of e-mails per year	4	57	166

Note: Data are the number of all the exchanged e-mails per month and per year by French teachers of all kind of disciplines.

posted by physics teachers in the PHYSCHIM list, the twelve interviews then give important information about their new roles and their new class practices. Our research is based on the following hypotheses: (i) that the introduction of TPEs and the associated rise of ICT use in class have changed the role of physics teachers; (ii) a discussion list like the PHYSCHIM list has also contributed to the integration of TPEs into the French educational system.

Results

The use of PHYSCHIM list by physics teachers

A first analysis of the messages and the interviews reveals some interesting points: primarily that using ICT effectively requires a radical transformation of teachers' communicative practices. In the PHYSCHIM mailing list a fairly general phenomenon for e-mail lists was observed (Rojo and Ragsdale, 1997), that is, that within a given period of time a few subscribers had posted a very large number of messages, a somewhat larger cluster had posted a moderate number of messages each and a lot of contributors had posted only a single message. In many of the messages physics teachers would often invoke personal experiences and ask if they have expressed themselves in ways that make sense to others. These discursive features reinforce the character of the PHYSCHIM list as a learning environment.

Some of the physics teachers used the list as a way of getting information and keeping updated in their field of interests, others to find out about new things to be done in class. Some physics teachers used the PHYSCHIM list as a means to participate in or listen to the exchange of messages whilst others used the list in order to find other teachers with similar interests or similar problems. There was a sense that it was felt very important to keep in touch with other teachers who have the same interests and the same questions. These list users also developed purposes as a group and collaborated on common goals. Some other physics teachers used lists to make announcements and others only to learn about this new medium. There was evidence of physics teachers exchanging and sharing ideas and material with their colleagues through the PHYSCHIM list. There was also evidence of French physics teachers developing the habit of helping each other via ICT, teaching one another, exchanging addresses of useful web sites and sharing exercises for their students.

The silent participants in the PHYSCHIM list

The presence of silent participants (lurkers) in e-mail lists may be also problematic in the sense that many subscribers seldom, if ever, contribute postings and therefore do not contribute to the production of collective goods in the virtual community. It is therefore worthwhile examining briefly the phenomenon of lurking in the PHYSCHIM list. Most users of the PHYSCHIM list appeared to participate mainly in a 'fishing for information' mode, while relatively fewer users were actively involved in the more interactive modes of 'enjoying the debate' or 'social networking'. The presence of non-posting readers on this list can occasionally be seen as troublesome but, on the other hand, among the silent participants, there may be a great number of silenced voices and teachers with things to contribute, who are too intimidated by the discourse to dare post their share. Lurking did not appear to be necessarily negative in the PHYSCHIM list that we have studied. The silent participant obviously does not contribute actively to the building of community; however, silent participation on the PHYSCHIM mailing list may be considered as a potential resource. We can regard lurkers as external elements to the community, as participants who read but never write a contribution and could be categorized as subscribers to the local newsletter.

Physics teachers' perspectives on ICT as a communicative and collaborative tool

As ICT becomes embedded in education, one of the most dramatic changes for teachers is loss of control. With ICT use it is the computer user who is in control – in education this is the learner. This is a radical change from the traditional situation where the teacher controls the class and the content of learning. Before ICT use, a teacher could guide learners in their individual work by recommending reading or directing them to a particular learning package. Now the learner seems to have the control of the classroom and for some teachers this is a rather difficult situation. Many individual pioneering teachers, such as those we interviewed for this study, were actively examining these new dynamics of use of ICT for teaching, learning and communication. For these teachers open access to the world of the Internet was seen as one of the major assets of the information society, but this new possibility also has many implications for teaching and learning, such as: (i) the increasingly dynamic nature of the content of learning; (ii) openness as to participation in learning; (iii) the need for learners to learn how to learn independently; (iv) the need for teachers to become facilitators and managers of learning.

Table 3 indicates teachers' perspectives on the communicative aspect of ICT use through the interviews with the twelve secondary school physics

teachers. For these teachers ICT use was seen as being very important mainly for the communication between themselves and their colleagues and students. Interestingly, far fewer teachers saw ICT as being a useful communicative tool for student-to-student or school-to-school contact.

Table 3
Physics teachers perceptions of the communicative aspects of the ICT use (x indicates a teacher's perception of ICT being useful)

Perceptions of ICT as a communication tool between . . .				
	Teachers and students	Teachers	Students	Schools
Int 1			x	x
Int 2	x	x		
Int 3	x	x	x	
Int 4	x	x		
Int 5		x		
Int 6	x	x		
Int 7		x		x
Int 8	x	x	x	x
Int 9	x	x		
Int 10	x	x		
Int 11		x		
Int 12	x	x	x	x

Physics teachers' perspectives on the new role of teachers

As physics teachers learn to live with ICT, it is argued that they often take on a role frequently described as 'guide on the side'. Their role becomes less dominant, since information and content are increasingly available using ICT. With the introduction of TPEs French physics teachers now need to provide advice on learning choice. Whilst in the 'traditional' system, learners had to follow a series of fixed steps, now they may travel a pathway with branches in a lot of directions. The notion that the teacher should have a role as manager is well established. In the new environment with ICT use in class practice, the teacher has the task of weaning the students from dependence on linear learning. New demands of autonomy are often made with the introduction of TPEs in the French educational system. A greater use of ICT can increase the potential for each individual learner to develop according to personal capacity.

A lot of messages in the PHYSCHIM list showed teachers seeing themselves as managers of learning. In the PHYSCHIM list French physics teachers often saw themselves as students' 'guides' and 'coaches'. After the introduction of TPEs, they had the impression that they were becoming their students' 'facilitator' and 'supporter'. It is very interesting to examine the different perceived roles of the physics teachers as expressed on PHYSCHIM (see Figure 1). One of their primary roles was seen as helping the students to determine a research topic for the TPEs. Thanks to the introduction of the TPEs it seemed that the physics teachers were now seeing themselves having become 'mediators' and 'mentors' for their students.

French physics teachers were aware of the fact that new teachers' roles are developing. Among these different roles, a new one is emerging, that of mentor (Kalogiannakis and Caillot, 2001). In an academic sense, mentor is often used synonymously with faculty adviser, yet a fundamental difference between mentoring and advising is that mentoring is a personal, as well as professional, relationship. An adviser might or might not be a mentor, depending on the quality of the relationship. A mentoring relationship develops over an extended period, during which a student's needs and the

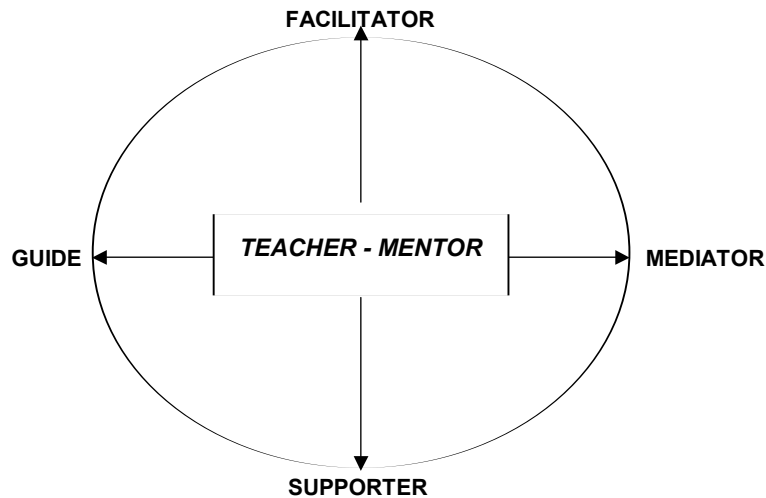


Figure 1
The new roles of French physics teachers as expressed through the
PHYSCHIM mailing list

nature of the relationship tend to change. A mentor will try to be aware of these changes and vary the degree and type of attention, help, advice, information and encouragement that he or she provides.

Discussion

The PHYSCHIM list is still being watched very closely and during the first seven months of 2002 the list reached 1,320 exchanged e-mails. This number shows that teachers are still greatly interested in this list. Many participants think that such e-mail lists are going to be an important avenue in the future for sharing information and practices as well as the attractiveness of the on-line interaction itself that makes teachers contribute messages. In the present analysis of the PHYSCHIM list there was a core of long-term participants who remained long enough on the list to provide sustainability, whilst there was also room for innovation through the addition of new resources and interests when new users join the list. In this respect the PHYSCHIM list can be considered to be a successful mailing list insofar as there are some teachers who sent messages at the opening of the list (November 1999) and still remained active two years later.

In all sectors of education, the role of the teacher is changing and French physics teachers need to complement their expertise in subject content and pedagogy by becoming facilitators and managers of learning. We have also come to understand the difficulties of transposing features from virtual environments of discussion between voluntary contributors into real class practice. A new culture of lifelong learning has emerged which means that more people are learning outside traditional educational structures. From this study it could be concluded that the PHYSCHIM list allows French physics teachers to 'meet' other colleagues, to keep and build contact with others. Teaching styles are also having to be transformed, which is a difficult thing when education culture is in transition from an old-fashioned centrally controlled system.

It is clear that ICT and TPEs in the French educational system require a modification of the role of the teacher, who in addition to classroom teaching will have other skills and responsibilities. After the introduction of the TPEs they feel like 'facilitators' and 'managers' for their students. Some physics teachers were using the PHYSCHIM list to get information, or just to listen to the exchange of ideas or to participate more directly in the debates by contributing themselves or by giving their opinion. Most French physics teachers recognize the main interest of TPEs in the secondary school.

With the inevitable proliferation of ICT in the classroom, the role of the teacher is changing and there are some key arguments why this must happen. First, the role of the teacher changes because ICT can cause certain teaching resources to become obsolete and new electronic forms of distributed communication can be employed. Second, ICT may also make some assessment methods redundant. Third, the role of the teacher must change in the sense that it is no longer sufficient for teachers to impart content knowledge. It will, however, be crucial for teachers to encourage critical thinking skills and collaborative working. One of the new roles of the teacher is to separate information from misinformation. Identification, classification and authentication of electronic information sources will therefore be critical new tasks for teachers in the near future.

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