Please cite the source as:

Laferrière, T. & Gervais, F. (2008). Teacher Education and Professional Development: Ten Years of ict Integration and What? *Revista Electrónica de Investigación Educativa, 10* (1). Retrieved month day, year from: http://redie.uabc.mx/vol10no1/contents-laferriere.html

Revista Electrónica de Investigación Educativa

Vol. 10, No. 1, 2008

Teacher Education and Professional Development: 10 Years of ICT Integration and What?

Formación del profesorado y desarrollo profesional: 10 años de integración de las TIC ¿y qué?

Thérèse Laferrière (*)
tlaf@fse.ulaval.ca

Fernand Gervais (*)
fernand.gervais@fse.ulaval.ca

* Faculté des Sciences de l'Education
Universite Laval, Quebec

2320 rue des Bibliothèques
Qc, G1V 0A6, Canada

(Received: September 23, 2007; accepted for publishing: March 5, 2008)

Abstract

This paper reports on designs for effective uses of ICTs in teaching and learning in teaching education. Applying Engeström's schema (1987) at three different levels of use of the computer as a cultural tool, three sociocultural accounts, each one reflecting a different design activity for the betterment of teacher learning environments, were constructed. For each, clusters of interactions at the university-school partnership, networked classroom, and virtual collaborative space levels are described. As the history of each activity is

presented, key features of the designed learning environments stand out, and trajectories of student teachers, teachers, and schools are highlighted.

Key words: Educational technology, information and communication technologies, teacher education, learning communities.

Resumen

Este artículo reporta acerca de los diseños para usos efectivos de las tecnologías de la información y la comunicación (TIC) en la enseñanza y el aprendizaje en la formación del profesorado. Mediante la aplicación del esquema de Engeström's (1987), que distinguen tres niveles de uso de la computadora como herramienta cultural, se econtraron tres motivos socioculturales de su utilización, cada uno de los cuales refleja un diseño distinto para la mejora de los ambientes de aprendizaje del profesorado. Para cada conjunto de interacción se describen niveles: el trabajo conjunto entre escuelas y universidad; aulas enlazadas por computadora, y espacios de colaboración virtual. Al presentar la experiencia de cada actividad, se destacan elementos clave de los diferentes ambientes de aprendizaje diseñados y se resaltan trayectorias de profesores en formación, profesores y escuelas.

Palabras clave: Tecnología educativa, tecnologías de la información y la comunicación, formación del profesorado, comunidades de aprendizaje.

I. Introduction

More and more researchers argue that ICT technologies are having a slow but increasing impact on how and what students learn (Becker, 1994; Davies, 2004; Kozma & Anderson, 2002; Fillion, 2005). It has also been widely documented that knowledge-building environments can help create various models of collaborative knowledge-building (Scardamalia & Bereiter, 1994; Lee, van Aalst & Chan, 2005; Hakkarainen, Muukonen, Liponen, Llomäki, Rahikainen & Lehtinen, 2001). Some of these models, such as ours, are inspired by a new perspective on cognition and a sociocultural point of view on activity as displayed in recent social and cultural theories of learning and cognition: situated cognition (Lave & Wenger, 1991; Lave & Chaiklin, 1993); distributed cognition (Hollan, Hutchins & Kirsch, 2000; Salomon, 1993); situated action (Theureau, 2004). This rather wide perspective on cognition and learning was translated in a few principles which became the foundation for the design of activities in networked classrooms, our main concern in teacher education and professional development. In fact, some of these principles were at the core of three design experiments (Brown, 1992; Collins, 1992, 1999) we conducted over the last ten years. In the first part of this paper we will describe how they relate to the aforementioned theories and secondly, how they unfolded in our various projects.

The perspective we adopted on cognition and activity has a few features we will highlight here in order to understand how our experiments unfolded. As we know, the body of knowledge related to it and which served as the foundation for our

experiments is not homogeneous; it comes from empirical works heavily grounded on various social practices (Wenger, 1998; Orr, 1996; Hutchins, 1995; 2000) or activities. But these research initiatives have at least one common goal: examine how one comes to learn in a concrete setting. Moreover, the focus here is not the individual performance or the development of a generic competence (applicable to all situations) of an individual but rather the collective performance and the development of *local competencies* shared among a group of individuals. Learning in a distributed way through a historically developing activity in a concrete setting or context was the cornerstone of our projects. In our case it involved a particular activity, the use and mastery of multifaceted cultural tools (ICTS) by students involved in a teacher education program and more specifically in a teacher development process. In the next sections, we will focus on how the use of ICTS generated a new form of learning for these students as translated in different trajectories. First of all, we will do so by examining the true nature of the activity from three angles: history, culture and context.

1.1 History and culture at the core of an activity

Needless to say, our representation of the computer as a cultural tool has evolved considerably over the last 20 years to the extent it transformed radically many aspects of our lives. Our own experience can shed some light on the phenomenon. It started out as a belief, not in the god given virtue of technology itself but on the *interaction potential* enhanced by technologies as cultural tools. The simple fact we were using these tools was perceived in itself as a new form of activity, appealing to some for its foreseen capacity, feared by others because of its potential dehumanization. It was somewhat misunderstood at the beginning for its unreliability and unfriendliness and also because of the ever present focus on mastering the tools. Things have changed since now we have reached another level as we use technologies to communicate, negotiate and construct meanings. In this paper we intend to highlight a few features of this new level of communication and negotiation of meanings as we have seen it unfold through our research projects over the last ten years. The setting in which it took place refers to a well-known activity in the process of experiencing major transformations in the years to come, according to many researchers and observers of the field (Barab, Kling & Gray, 2004; Kozma & McGhee, 2003). In fact, the activity we are referring to, namely teaching, has a long history of institutionalization and has been often affected by trends and the *latest* innovation. But this time many think it is different as new technologies are invading all aspects of our lives.

When considering this so-called invasion of technologies in the educational system we have to bear in mind some practices, namely traditional teaching, have been prevalent over many decades if not centuries. In fact, traditional teaching is still the dominant form of practice across the world. The belief that teacher-centered interactions best determine what is learned and how learning takes place is deeply rooted in the teaching profession. Teachers who want to create learning environments and implement technopedagogical designs that provide for peer interactions encounter contradictions of all sorts. Among others, they face the

challenge of developing deep understanding of what social cognition is, and of negotiating with colleagues, school administrators and even teacher educators who hold shallow understanding of what the co-construction of knowledge entails. With regards to ICTs, Becker & Riel (2000) found that constructivist teachers were more inclined towards using the Internet in the classroom than traditional teachers. To our knowledge, no national study has focused on the practice of teachers while adopting a social framework. We feel it is urgent to head into that direction. "From this perspective, learning is as much a matter of enculturation into a community's ways of thinking and dispositions as it is a result of explicit instruction in specific concepts, skills, and procedures" pointed Putnam & Borko (2000, p. 5). The metaphor of participation versus acquisition illustrates the duality.

1.2 The overarching context

The province of Quebec, Canada, is going through an educational reform aiming at a better preparation for school learners of the 21st Century. In its early days it was inspired by a constructivist and socio-constructivist perspective. In spite of its urgency, the implementation, which is now reaching the secondary education level, encounters ups and downs. Various kinds of support have been offered at the local level to teachers who want to create learning experiences aligned with the reform agenda, thus creating a situation with reduced contradictions using Engeström's perspective (1987; Engeström & Miettinen, 1999). Nonetheless, distributed cognition (Salomon, 1993; Hollan, Hutchins & Kirsch, 2000) in a single school is unsufficient to align pedagogy with the goals of the reform, and few teachers move along and prefer to wait for apparently related curricular and assessment materials. Teacher networks for educational reform (Lieberman & Grolnick, 1996; Lieberman, 2000) are not taken hold in Quebec as they do in the United States. Such teacher networks, however, rarely use advanced online collaborative tools[1] to support educational reform.

In the concrete settings we have been involved over the past ten years, advanced collaborative tools have been experimented, namely two electronic forums (Knowledge Forum, Virtual-U VGroups), and one multi-user desktop videoconferencing system (iVisit). Their use was first guided by the professional development school model (Holmes Group, 1990), the reflective practitioner approach to professional development (Schön, 1983), the notion of distributed cognition (Salomon, 1993), and the works of key designers of computer-supported collaborative learning environments including Bereiter and Scardamalia (1993) and Scardamalia and Bereiter (1994). With the contribution of other Canadian colleagues engaged in teacher education and research at other sites (Laferrière, Breuleux, & Erickson, 2004), by the year 2002 twelve principles were considered valid for the design of computer-supported collaborative learning environments.

1.3 Twelve principles

These principles are the outcomes of our collaborative knowledge building design process as they relate to teacher education and professional development. Our

focus meant to be multidimensional as we tried to capture various aspects covered by the experiments.

1. Ease of access. Networked computers and online resources and tools need to be accessible without loosing too much time once basic technical skills are mastered.
2. Co-constitutionality. The development of a socio-technical infrastructure relies first on electronic connectivity on the one hand, and on people who value collaborative learning and knowledge on the other.
3. Participatory design. The development of networking capacity involves university-school administrators (partnerships), university- and school-based teacher educators, in-service/pre-service teachers, and K-12 learners.
4. Local grounding. Site-based professional learning communities provide grounding.
5. Active collaborative learning. The networked classroom fosters active collaborative learning, rather than individual learning where students/pupils work on computers learning rote knowledge and specific skills.
6. Multi-modal social interactions. At a local level, learners meet face-to-face. Learners also meet online, pursuing locally grounded activities or geographically extended activities.
7. The classroom as-a-community of learners. K-12 learners as well as pre-service and in-service teachers are learning in networked classrooms designed to become centers of inquiry where people, things, and ideas are valued, and where teaching for understanding is a common goal.
8. Diversity. Learning communities are different in their local champions, circumstances, settings, tools, artefacts, cultures, and languages (English, French, Catalan).
9. Progressive distributed expertise. Virtual collaborative spaces provide opportunities to share resources and expertise to solve complex and ill-structured problems.
10. Collaborative reflective teaching. The design task is that of providing a collaborative learning environment within which problem-setting and problem-solving are carried out in relation to real classroom events.
11. Collaborative knowledge building. This refers to the design of a rich learning context within which meaning can be negotiated and ways of understanding can emerge and evolve.
12. Interrelatedness. Knowledge objects, events, actors, artefacts, and authors interconnect in ways that add continuity and integration to student teachers' experience as they learn to teach in networked classrooms. They add as well to the experience of practitioners' working in networked classrooms.

Applying Engeström's schema (1987) at three different levels of use of the computer as a cultural tool, we present, in the following section, three sociocultural accounts, each one reflecting a different design activity for the betterment of teacher learning environments. For each, clusters of interactions at the university-school partnership, networked classroom, and virtual collaborative space levels are presented. As the history of each activity unfolds, we will expose key features of

the designed learning environments, and get a sense of the emerging culture of teaching and learning in networked classrooms.

II. Account one: Learning to use ICTs to improve field experiences in pre-service teacher education

The first design experiment began with university-based teacher educators and school-based teachers infusing ICTs into their practices to improve the learning environment for pre-service teachers and later focused on pre-service teachers' online discourse for collaborative reflective practice and knowledge building. Ethnographic methods were used to gather data, including virtual ethnography in electronic forums before, during and after student teachers' four-month long practicum.[2]

2.1 Interaction at the university-school partnership level

From 1995 to 1999, the object-outcome put forward by the leading teacher educator and main researcher was clearly an improvement of the learning environment (object-outcome) offered to pre-service teachers during field experiences. The subjects (or partners) were university and school-based teacher educators, willing to use the computer and Internet-based software (tools) to bridge the gap between universities and schools, a situation heavily documented in the teacher education and professional development field (Holmes Group, 1990; Clifford & Guthrie, 1989; Hawley & Valli, 1999) and which manifest itself in some cases when student teachers are more influenced by school-based teachers than by university-based teacher educators. Could ICTs' use help transform the way the three types of protagonists (the community) interact with one another?

The betterment of the learning environment was conceived as the result of using ICTs to strengthen communication and foster greater coherence between theory- and practice-driven teacher education and professional development (Ellsworth, 2000; Thompson, Schmidt, & Davis, 2003).[3] A school-within-a-school student-owned laptop program (PROTIC, http://www.protic1.net) covering all subject matters was established in 1997 for high school students. At the university, a networked community entitled TACT (Technology for Advanced Collaboration Among Teachers, http://www.tact.fse.ulaval.ca) was established. At first, a few volunteered student teachers involved in field experiences (cohorts of two in 1997; four in 1998, and, since then, six or seven each semester) participated in the project. These were the main innovative features injected in the student teachers' learning environment during their field experiences.[4] They provided numerous opportunities for meaningful conversation between school-based teachers and university-based teacher educators and researchers.

The 1999-2001 years consolidated the physical, social, and virtual dimensions of this innovative context: the PROTIC program extended to all high school years and to one-third (375) of the school population (1,100 students) while student teachers

engaged in on-line forums in addition to on-site meetings with their teacher educators and peers.

During the 2001-2004 years, these hybrid environments[5] matured into networked communities. More and more attention could be given to learning outcomes – the latest stage in a training program evaluation according to Kirkpatrick (1975, 1994) or Gusky (1999). The first cohort of high-school graduates (école Les Compagnons-de-Cartier, PROTIC program) graduated to college, and the university-school partnership extended to include one of them (*Collège d'enseignement général et professionnel* –CEGEP– de Ste-Foy) which developed its own laptop program (Pascal). It took shape in a research project (follow-up) whose intent was to document the performance of the PROTIC graduates during their college years. As the PROTIC program expanded to a larger number of students or inspired other initiatives of a similar sort, Laval University's graduate students in Education started to exercise some teacher leadership with regards to the use of ICTS in hybrid learning environments and most stay "virtually" connected to the TACT community.

2.2 Interaction at the classroom community level

Increased interaction at the organizational level resulted in the creation of hybrid environments for both school learners and pre-service teachers, teacher educators and teachers (subjects). The new context supported cooperative/ collaborative enquiries but dynamic structuring of activities (Vygotsky, 1987; Wertsch, 1979) was also required.

During the 1999-2001 period, classroom learners worked as teams in project-based activities involving their teacher(s) and practicing teachers(s) interacting face-to-face, searching information or producing artefacts on the Web and, at times, interacting online with different partners: students part of their team, from another school, undergraduate and graduate university students, and outside experts. Meanwhile, pre-service teachers engaged in collaborative reflective practice mainly with regards to classroom organization and management of a student owned laptop (or networked) classroom and project-based learning in such a context. The object-outcome set by teacher educators was related to the student teachers' potential for reflective practice, but in order to do so they could select different means. Scaffolding was provided by setting up rules congruent with Habermas' ideal speech situation, that is, of a democratic discourse (see White, cited by Lawley, 1992): 1) Each subject who is capable of speech and action is allowed to participate in discourses; 2) Each is allowed to call into question any proposal; 3) Each is allowed to introduce any proposal into the discourse; 4) Each is allowed to express his attitudes, wishes, and needs; 5) No speaker ought to be hindered by compulsion – whether arising from inside the discourse or outside of it. Moreover, conversation and action were meant to complement each other for the co-construction of knowledge: practice led to negotiation of meaning, and clarification of meaning suggested relevant actions. Collaboration, however, was

more explicit in student teachers' individual work with their cooperative teacher or the team of teachers with which the latter was working more closely.

At the content level, the technical dimension was paramount: how to make sure that the curriculum is covered? How to "sell" one's project to a whole classroom? Is the computer necessary to do project-based learning? School learners created learning and knowledge building artefacts linked to the high school curriculum whereas student teachers and teachers created ones, in collaboration with teacher educators and researchers, related to teaching in a networked classroom. During that period the twelve design principles of a networked classroom were put forward: Ease of access, Co-constitutionality, Participatory design, Local grounding, Active collaborative learning, Multi-modal social interactions, The classroom as-a-community of learners, Diversity, Progressive distributed expertise, Collaborative reflective teaching, Collaborative knowledge building, and Interrelatedness.

During the 2002-2004 period, the PROTIC teachers and practicing teachers (subjects) discourse became more explicit with regards to ICTS' uses (tools) for supporting classroom-based learning communities. The concept of the learning community, introduced by a university-based teacher educator (Grégoire, 1997), became meaningful for both the PROTIC professional learning community and the pre-service learning community. Given the importance of pre-service teachers within the TACT community (pre-service teachers, graduate students, teacher educators and researchers), the latter focused its use of ICTS and gave priority to tools that better supported on-line interaction (collaborative learning) within and across learning communities.

2.3 Interaction in the virtual space for collaborative learning and knowledge building

Social interaction for learning (Vygotsky, 1978) was intricately related to the context, that is, the socio-technical designs that made sense to participating subjects, especially pre-service teachers. For teacher educators, collaborative reflective practice was a discursive process leading to the sharing and negotiation of meanings with others in a dialog perspective (Bruner, 1986; Strike & Soltis, 1998).[6] The dialogic process became an authentic one, even for the student teachers completing their practicum in a *regular* classroom as opposed to PROTIC classrooms part of the same school and supervised by the same university-based teacher educator. By 1999, student teachers involved in both clearly manifested a preference for collaborative rather than individual journal writing, problem setting and problem solving. Collaborative problem solving was presented by the teacher educator as the co-construction of a shared understanding of a problem (Roschelle &Teasley, 1995).

The analysis of conversations conducted during the 1999-2001 period on Virtual-U VGroups revealed that student teachers involved in PROTIC classrooms were confronted with their own traditional beliefs and those of their peers regarding

classroom processes and learning in a narrow fashion. They were not questioning the use of the laptop computers but questioning how to use them in networked classrooms: classroom organization and management, planning, evaluation of cooperative/collaborative learning activities and projects. The student teachers' discourse involved in *regular* classrooms (non-laptop classrooms of the same school) contrasted: year after year, the relevance of the computer as an important tool in the classroom was always questioned. At best, their innovation-oriented discourse referred to cooperative learning activities. The lack of progressive discourse regarding the use of the computer influenced the teacher educators' decision to split the group of student teachers[7] for the following iteration of the design experiment, one during which Knowledge Forum was to be used instead of Virtual-U VGroups.

During the 2001-2004 period, the discourse of PROTIC student teachers' completing their internship was oriented toward collaborative knowledge building (Laferrière, 2005). Online conversations gained in focus and authenticity – See Brown, Ash, Rutherford, Nakagawa, Gordon & Campione (1993) definition of authentic problems, that is, ones fostering the kinds of thinking and problem-solving skills of teachers working in networked classrooms from a socio-constructivist perspective.[8] Argumentation during problem solving led to some instances of knowledge building (Campos, Laferrière & Lapointe, in press). Moreover, student teachers' discourse became less techne-oriented and more phronesis-oriented (Allaire, 2006).

III. Account two: Learning to use ICTS to establish classroom-based learning communities

The second design experiment (1998-2001) took place within the university-school partnership previously described. Our intent was to examine the use of ICTS in networked classrooms. The main sources of data were participant observers' notes, focus groups, interviews with teachers and school learners registered to the five-year laptop program (PROTIC) that began in 1997 and the online discourse of the classroom-based learning communities.[9]

3.1 Interaction at the university-school partnership level

The partners (subjects)' intents were formulated by teacher educators, school teachers and pre-service teachers working together to understand the effective use of laptop computers (tools) in networked classrooms. They adopted a reflective practitioner model (Schön, 1983) to this end, and interacted with one another to clarify intents and expected results. More experienced teachers transferred their knowledge to the new setting and gave the activity a new twist. The consensual organizational model that emerged (object-outcomes) with regards to the betterment of the learning environment with the use of laptop computers was the classroom-based learning community. Our learning community was characterized by democratic processes, student engagement, role flexibility, meaningful learning tasks and projects, and various forms of evaluation. Online tools were meant to

support such an activity. Meaning negotiation as regards effective use of ICTs included: negotiating the purpose of going online for within-the-classroom communication; sorting out online tools providing better learning affordances (Google; Inspiration; Knowledge Forum, and others). In order to understand how intents and results could meet – the definition given to effective use of student-owned laptop computers – three iterations were conducted, each leading to the rewriting of the same booklet describing the practice of integrating ICTs in student-owned laptop classrooms (Partenariat PROTIC-FCAR-TACT, 1999, 2000, 2001).

3.2 Interaction at the classroom community level

The notion of a classroom-based learning community encompassed face-to-face and on-line interaction. The former was multiform as school learners were part of teams of four, seated together at a table facing each other with connected laptops (electricity and Internet). Oddly enough, during lectures – for significantly less time than in regular classrooms – the networked (laptop) computer tended to be a nuisance and a source of tension in the classroom for pre-service teachers or beginning teachers. User rules appeared vague or blurred. Teamwork was everyday practice, even more so during project-based learning. Pre-service and beginning teachers had to find ways for scaffolding. Of course, this was less a problem for experienced teachers. Peer-evaluation was promoted as another form of face-to-face interaction. As regards online interaction, patterns of communication within the classroom and with the outside world, including parents and experts, and using a variety of tools were manifold: teachers' websites posted classroom schedules, scripts regarding teacher-driven learning activities and projects, guidelines regarding learner-centered projects. Electronic forums were popular but Knowledge Forum was restricted to some classrooms, and its use negotiated with school learners (e.g. for within-the-classroom communication, learning and knowledge building).

3.3 Interaction in the virtual space for learning and knowledge building purposes

The online tools were used at a primary level to share information, it did not require meaning negotiation per se except for what may have preceded the "delivery of a final product" by a given team or classroom. In Knowledge Forum, textual traces make one's thinking public and the thrust is toward idea improvement. It is therefore a fruitful process, and one that adolescent school learners having plenty of software to their disposal have to be persuaded of engaging into. For a better understanding of what the pedagogical communication may entail in such a complex setting, ninth graders were selected as a group. Through onsite and online ethnography, we identified features in the discourse of the schoolteacher, for instance when they attempt to transform classroom-based learning communities into knowledge building communities. Meaning negotiation, attention to metacognitive activity, persistent scaffolding attempts, and use of the Knowledge Forum Analytical Toolkit for student evaluation typified her activity. As regards all PROTIC classrooms, their discourse, compared to discourse in classrooms not using

ICTS, stood out for the density of peer-to-peer interaction and meaning negotiation. Students' motivation and levels of writing complexity were higher when compared by conventional means (Lemonnier, Gagnon, Huot, Hamers & Parks, 2001).

IV. Account three: Learning to use ICTS in remote networked schools

In the third design experiment (2001-2006) we transferred the knowledge building process to a new setting. Issues of ownership, productivity, sustainability and scalability of use emerged in the overall design of the remote networked school.

4.1 Interactions at the university-school partnership level

Our partnership included the Ministry of Education and the Centre francophone d'informatisation des organisations (CEFRIO), the latter being a liaison and transfer unit whose mission is to support Québec organizations with information technologies for efficient, productive and innovative purposes. The two organizations have been interacting with our research team with regards to the nature of the initiative (its top-down dimension). Researchers from three universities, Laval University, McGill University, and University of Quebec at Chicoutimi, interact with school district and school leaders and personnel. All participants are invited, including school learners, to design their own remote network school (object-outcome). A wide participation is welcome at the local level, including parents and municipality officials, as well as at the provincial level (the bottom-up dimension). Other educational partners expressed a strong interest for the project (the Fédération des commissions scolaires du Québec, la Centrale des syndicats nationaux, and others). During Phase One (2001-2003), the participants worked at three local sites and interacted on-site and on-line with the university-based R & D teams. A top-down decision restricted the number of online tools (tools) used for research purposes: iVisit, Knowledge Forum, and a locally designed tool for project-based collaborative learning (ZAR).

Year 1 was a planning year. Four iterations were designed for better understanding of the technology innovation, conditions, teacher beliefs, activities conducted online (tools, discourse, roles, and routines), and learning outcomes, including student academic results. Phase Two (2004-2006) was dedicated to the interpretation of teacher and student online discourse displayed under the circumstances. Whereas the intent of the researchers (as subjects and interveners) was to rise the level of complexity with regards to the reading and writing process during and beyond project-based learning, networked classroom participating teachers' intent (as subjects and interveners, 13 sites and over 100 teachers involved) was first and foremost to understand the value of online tools to improve the learning environment. A particular impact of this initiative was to strengthen (in part or as a whole) the local professional learning community. Teachers have onsite and online (just-in-time) support available through their local school district or the university-based team. Of the three design experiments, this one has had the largest scope and been most conducive to tensions between protagonists.

4.2 Interaction at the classroom community level

Multi-leveled classrooms were found in both our elementary and secondary remote schools. It is not unusual to find school learners from one grade involved in individual tasks while the teacher is working with students from the other grades. In a small number of classrooms, teamwork or cooperative work was already well established. Project-based learning and the classroom-based learning community model were new to almost all teachers. Learning activities and projects can be conducted online (in collaboration with learners and teachers from other schools) once large bandwidth is reliable and basic use of tools is mastered. But pedagogical use does no depend only on technological means: in both phases of the project, some teachers in classrooms with lesser connectivity have engaged school learners in collaborative inquiry projects of a greater complexity than some with better connectivity.

4.3 Interaction in the virtual space for learning and knowledge building purposes

Oral and online conversations unfolded between participants (school teachers, learners and administrators) from different schools or with university-based teacher educators. Phase One results were encouraging in both quantitative and qualitative terms regarding online interaction using iVisit. Knowledge building indicators were also encouraging at the two (out of three) sites that made use of Knowledge Forum. Teacher online discourse (peer-to-peer professional development) was analyzed during planning and/or reflection on online learning activities as regards teaching beliefs. Phase Two results will be published in 2006.

V. Discussion

5.1 The networked classroom as a new workplace for teachers

We found out the cultural tools available to both teacher educators and pre-service teachers) transformed their work setting, and shaped their perspective on teacher development. For instance, the learning environment for pre-service teachers' field experiences proved to be more integrated and coherent with the scholarly notions they had been familiarized with in the university setting. Work in a networked classroom was found not to be restricted to what goes on within its four walls as outside participants are invited to join specific learning activities and projects. In fact, it creates a web of networks as small groups interact as learning and knowledge-building artifacts form a large database accessible from year-to-year. Knowledge management engenders new practices (websites, electronic portfolios, virtual tours) congruent with others that become more and more part of our everyday lives (MSN and so on). Providing authors' permission, databases of knowledge building communities are analyzed by local or international school learners, teachers and researchers. Expertise as progressive problem solving becomes the trajectory for all concerned.

This trajectory goes beyond best practice at this point in time. The potential is there but it may not unfold except in protected settings. By analogy, let's recall here the operating room of the medical surgeon before electricity. As this technology became available, new equipment rolled into that room and is now reaching a very high level of sophistication. But as electricity was rolled out into classrooms, its impact on the activity of schoolteachers and learners was rather one of convenience than one of increased complexity of the teaching-learning activity. In fact, because of the public nature of schooling and teaching it takes more time for technology to find its way into classrooms. As Brown and Duguid (1996) pointed out quoting George Landow:

> Perhaps it is just a matter of lag: it took only twenty-five years for the overhead projector to make it from the bowling alley to the classroom. I am optimistic about academic computing; I've begun to see computers in bowling alleys! (p. 10).

Ultimately, with or without an educational reform to align practice, most classroom-based technopedagogical designs are the results of teachers' will, knowledge and skill.

This new open-ended workplace is congruent with principles brought forward by sociocultural perspectives for understanding cognition and conducive with the informal learning that takes place in communities of practice (Lave & Wenger, 1991). It is also aligned with a conceptualization of professional development as participation in school professional learning communities (Fullan, 1993; Dufour & Eaker, 1998) or the design of network-based professional communities of practice (Barab *et al*., 2004), are instrumental in balancing the role of individual and distributed cognition.

5.2 Student teachers' trajectories

We found evidence of some particular student teachers trajectories in Account 1. The pre-service teachers (subjects) initiatives while using ICTS (tools) in the wake of their future legitimate practice took shape while they joined the knowledge building community interested in designing the networked classroom (object-outcome). Knowledge and skills were acquired as they enacted their knowledge, beliefs, and attitudes in networked classrooms and reflected upon their practices on-site and on-line with peers, more knowledgeable and skilled practitioners, and university-based teacher educators. To be capable of further advances, the latter (subjects) engaged in meaning-making and knowledge-building (object-outcomes) with other colleagues (proximal community) on-site and on-line (distributed communities), for example, in student teachers' descriptions of student engagement in learning projects supported by ICTS, in the teacher's role as a guide in a networked classroom, in the development of cohesion within a classroom-based learning community. Mediating artifacts and signs (e.g. online discourse), object-outcomes, roles (division of labor), stated or tacit rules and routines kept evolving in the classrooms of those that kept expanding their individual knowledge and skills through the resources and opportunities provided by the communities they joined. For instance, beginning teachers and incoming pre-service teachers

joined a professional culture and expressed a strong sense of ownership in the PROTIC-TACT partnership.

Considering student teachers trajectories over the years, we have come to realize newcomers have only perceived some of the affordances provided by this new learning environment (Allaire, 2006). Moreover, while the design keeps improving it has not transferred yet to other areas of inquiry, that is, to ones to which other teacher educators/researchers within the same institution or elsewhere are committed. It may be that the model and its outcomes as regards teacher education and professional development have not been made explicit enough.[10] It may also be that the affordances of ICTs are perceived as being technical rather than social and, consequently, as presenting little interest for the professional practice of those part of a culture favoring technology minimalism. It may be that the proliferation of new Internet-based technologies has provided too many opportunities simultaneously and that each new adopter can engage in technopedagogical designs and join related communities of practice of their own preference. In any case, knowledge building with regards to a networked classroom still has a long way to go. Many more object-outcomes will have to be provided to practitioners on university or school campuses to accelerate the integration process of specific ICTs to create more powerful hybrid learning environments (or technopedagogical designs).[11]

5.3 Teachers' trajectories

Account Two focused on the activity of a single school-based professional learning community (PROTIC) whose teachers have been uncovering the meanings and affordances of the networked classroom. School administrators' leadership was present, one that fostered distributed leadership and parent involvement and support. Opportunities to meet during school hours were provided. Researchers helped understanding practice and learning outcomes. The school district supported their innovative work in both technical and political ways. The program gained credibility, and later served as a lighthouse to the implementation of the Quebec educational reform. Since, the school district has initiated two similar programs in elementary schools, a community college has created a laptop program in order to adapt to graduates from the PROTIC program. Moreover, the program is now well established within the school, another innovative program in which ICTs are used[12] has been implemented and teachers working in the regular program are slowly engaging into using ICTs.

Limits identified in schoolteachers' practices of use had to do with their understanding of the Internet and the Web. The Web is the Internet application that made Internet popular in the mid-nineties.[13] Access to information and sharing of information were seen as the basic functions of the Web whereas advanced Internet-based collaboration tools raised less interest. The former functions are aligned with individual learning and the belief that cognition is in the head rather than distributed. This belief remained dominant within the PROTIC community, one inclusive of schoolteachers, administrators, pre-service teachers, school learners

and parents. The principles guiding the design of Knowledge Forum are derived from the distributed cognition perspective and are, therefore, not aligned with mainstream thinking. Another limit was that of school learners finding Knowledge Forum less attractive than some other software available on their laptop computer. The minority of teachers who used Knowledge Forum promote its learning value to their students, and some get most interesting results (Ménard, Allaire, McLelland & Laferrière, 2003).

5.4 Schools' trajectories

Account Three offered a different context of use of Knowledge Forum (remote rural schools). The choice of this tool was a top-down decision, one influenced by pedagogical and practical purposes. For instance, this was a tool which had been designed on the basis of solid cognitive science principles. Moreover, its was a tool to which semi-automated analytic tools could be added. At first, some locally-based ICT specialists would have preferred tools with whom they were familiar.[14]

For collaboration within and between sites, the use of the same platform was a necessary support for oral and written discourse (same conferencing systems). The selection of a platform comes next to the connectivity issue for a school.[15] In the Remote Networked School Initiative, last-year learning artifacts deposited on Knowledge Forum have become exemplars, demonstrating student capacity to inquire into driving questions. Teachers from one school have evidence to show when other teachers express doubts about the students' overall capacity to do so or the actual connection of such activity to the curriculum. A network of remote networked schools is emerging slowly, and its culture unfolds through artifacts, rituals, stories and boundaries. For instance, developing routines are ways in which on-site and on-line conversations converge for school teachers and learners. Schools are developing a capacity to network their activity. Early examples that incoming participants (substitute teachers, beginning teachers, experienced teachers) are being enculturated into the emerging remote network school culture are: an actual task description by a school administrator, previous activity narration by school learners, teachers' stories regarding what worked and what did not work, etc.). However, there are plenty of limits regarding the integration of this technopedagogical in other settings. These limits are systemic and they reflect powerful cultural schemes of Quebec schools, one embedded in conventional teaching and organizational management of large schools. Will practices developed in remote small schools scale will have an impact in larger schools or will the resilient practices of large schools find their way back into small schools once the Initiative is over?

5.5 Design principles and participants' trajectories

Informed by a sociocultural perspective, the technopedagogical designs presented above were respectful of the contexts of use of specific ICTs. Moreover, the very activity of using common specific ICTs transformed these contexts in ways reflected by the trajectories of student teachers at Laval University, PROTIC teachers learning

to work in networked classrooms, and schools of the Remote Networked School Initiative. In all three accounts, the design principle ease of access to the new tools was critically important to the process of transforming the interaction between subjects and their environment for achieving intended results (object-outcomes). Connectivity meant to rely on the electronic network (Internet) but also on the social network of participants be they teacher educators, school teachers or administrators (design principle: co-constitutionality). This principle proved to be most helpful to enact participants' intentions. Moreover, their interactions enabled participatory design. All technopedagogical designs presented were locally grounded in the actual practices of teacher educators, student teachers, teachers and school administrators. In all three accounts, participants became interested in collaborative applications of ICTs. However, trajectories of collaborative practices did not begin with the use of computer-supported collaborative tools but the latter enabled more sustained practices of collaboration. In the networked classroom or school both individual and collaborative learning are co-existing practices. Active collaborative learning takes place through on-site and on-line interaction (design principle: multi-modal social interactions). Networked communities were all developed (TACT, PROTIC, Remote networked schools), with an interest in the classroom as-a-community of learners. While they showed diversity in their local champions, circumstances, settings, and cultures they made an increasing use of the same tool for written discourse. Knowledge Forum provided them with virtual collaborative spaces to share resources and expertise within and between sites (design principle: progressive distributed expertise). Student teachers reflected on-line on the organization and management of the networked classroom and the conduct learning projects (Design principle: collaborative reflective teaching). And teachers helped one another in scaffolding online classroom conversations (Design principle: collaborative knowledge building). Finally the three accounts demonstrate that last design principle, interrelatedness, was enacted as knowledge objects, actors, artifacts and authors interconnected in ways that added continuity and integration to preservice teachers', teachers', and teacher educators' experience.

After ten years of sustained collaborative inquiry into effective uses of ICTS in classrooms and schools, we are more convinced than ever that technopedagogical designs must reflect thoughtful consideration of history, culture and context. New stories reflective of ICT integration and related practices of use can unfold. Their sustainability and scalability require powerful and accessible tools used by participants who create networked communities of use within and beyond supportive local communities.

VI. Conclusion

We intended to offer a coherent picture of an activity system in progress in this paper, that is, ICT integration in teacher education and professional development. We provided three accounts involving different subjects, object-outcomes, communities. In each account, participants, using similar or different new tools within their own community, engaged into new division of labor (roles) and some

new routines emerged. Mediating artifacts resulted, and became accessible to other networked communities adopting similar goals regarding ICT integration.

Together these constituents of the emerging activity system(s) provide a coherent picture of what ICT integration entails and how it provides empowerment in classrooms and schools. In each account, the context was a three-layer learning environment: the university-school partnership, the networked classroom, and the virtual collaborative space. Organizational partnerships created hubs of innovation, university-based and school-based participants working collaboratively to develop technopedagogical designs and also delineate relevant research questions. Together, they pushed the boundaries of their own individual teaching and that of their collaborators but encountered real and authentic new problems in their practices of use.

In the wake of the use of the computer and Internet-based software for teaching and learning, we are aware of having contributed only a drop in the bucket, that is, the renewal of teaching and learning practices. We keep being remembered of the following quote: “Collaborative technologies offer the transformation of teaching and learning to take us into new situations for which we do not yet have the pedagogic techniques” (McCormick, 2004, p. 173).

References

Allaire, S. (2006). *Les affordances socionumériques en soutien à l’analyse réflexive dans un environnement d’apprentissage hybride pour des stagiaires en enseignement*. Doctoral dissertation in preparation, University of Laval, Québec.

Becker, H. (1994) *Analysis and trends of school use of new information technologies*. Washington, DC: U S. Congress Office of Technology Assessment-U.S. Government Printing Office.

Becker, H. J. & Riel, M. M. (2000). *Teacher professional engagement and constructivist-compatible computer use* (Report No. 7). Irvine, CA and Mineapolis, MN: University of California, Irvine and University of Minnesota. Retrieved March 6, 2006 from http://www.crito.uci.edu/tlc/findings/special_report2/html/report.htm

Barab, S., Kling, R., & Gray, J. H. (2004). *Designing for virtual communities in the service of learning*. New York: Cambridge University Press.

Bereiter, C. & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature and implications of expertise*. Chicago and La Salle, IL: Open Court.

Berners-Lee, T. (1999). *Weaving the web*. San Francisco: Harper San Francisco.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, *2* (2), 141-178.

Brown, J. S., & Duguid, P. (1996). Universities in the digital age. *Change, 28* (4), 10-19.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18* (1), 32-42.

Brown, A., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J. C. (1993). Distributed expertise in the classroom. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 188-228). Cambridge: Cambridge University Press.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Campos, M., Laferrière, T., & Lapointe, J. (2005). Analysing arguments in networked conversations: The context of student teachers. *Canadian Journal of Higher Education, 35* (4), 55-84.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18* (1), 32-42.

Clifford, G. J., & Guthrie, J. W. (1989). *Ed School: A brief for professional education.* Chicago: The University of Chicago Press.

Collins, A. (1992). Toward a design science of education. In E. Scanlon & T. O'Shea (Eds.), *New directions in educational technology* (pp. 15-22). New York: Springler-Verlag.

Collins, A. (1999). The changing infrastructure of education research. In E. Condliffe Lagemann & L. Shulman (Eds.), *Issues in education research* (pp. 289-198). San Francisco: Jossey-Bass Publishers.

Davies, D. (2004). Designing the best: A Review of effective teaching and learning of design and technology. *International Journal of Technology & Design Education*, *14* (3), 207-221.

Dufour, R. & Eaker, R. (1998). *Professional learning communities at work: Best practices for enhancing student achievement*. Alexandria, VA: ASCD.

Fillion, G. (2005). *L'intégration des TIC dans la formation universitaire: Une étude des résultats éducationnels des étudiants dans les contextes de présence et de non présence en classe.* Unpublished doctoral dissertation, Université Laval, Québec.

Fullan, M. (1993). *Change forces.* London: Falmer Press.

Ellsworth, J. (2000). *Surviving change: A survey of educational change models*. Syracuse, NY: ERIC Clearinghouse on Information Technology.

Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki, Finland: Orienta-Konsultit.

Engeström, Y. & Miettinen, R. (1999). Introduction. In Y. Engeström, R. Miettinen & R. Punmamäki (Eds.), *Perspectives on activity theory* (pp. 1-18). New York: Cambridge University Press.

Gilly, M., Roux, J. P. & Trognon, A. (1999). *Apprendre dans l'interaction. Analyse des médiations sémiotiques*. Nancy et Aix en Provance, France: Presses Universitaires de Nancy.

Greeno, J. G., Collins, A. M., & Resnick, L. B. (1996). Cognition and learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15-46). New York: Macmillan.

Grégoire, R. (1997). *Communauté d'apprentissage, une définition*. Retrieved March 12, 2006 from http://www.fse.ulaval.ca/fac/tact/fr/html/prj-7.1/commune2.html

Gusky, T. R. (1999). *Evaluating professional development.* Thousand Oaks, CA: Crowin Press.

Hakkarainen, K., Muukonen, H., Lipponen, L., Ilomäki, L., Rahikainen, M., & Lehtinen, E. (2001). Teachers' information and communication technology (ICT) skills and practices of using ICT. *Journal of Technology and Teacher Education, 9* (2), 181-197. Retrieved May 2, 2006 from http://dl.aace.org/6438.

Hawley, W. D. & Valli, L. (1999). The essentials of effective professional development: A new consensus. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 127-150). San Francisco: Jossey-Bass.

Hollan, J., Hutchins, E., & Kirsch, D. (2000). Distributed cognition: Toward a new foundation for human-computer interaction research. *ACM Transactions on Computer-Human Interaction, 7* (2), 174-196.

Holmes Group. (1990). *Tomorrow's schools: A report of the Holmes Group*. East Lansing, MI: Author.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: The MIT Press.

Hutchins, E. (2000). The cognitive consequences of patterns of information flow. *Intellectica, 30,* 53-74.

Kirkpatrick, D. L. (1975). *Evaluating training programs*. Madison, WI: American Society for Training and Development.

Kirkpatrick, D. L. (1994). *Evaluating training programs: The four levels.* San Francisco, CA: Berrett-Koehler.

Kozma, R. B. & Anderson, R. E. (2002). Qualitative case studies of innovative pedagogical practices using ICT. *Journal of Computer Assisted Learning, 18* (4), 387-394.

Kozma, R. B. & McGhee, R. (2003). ICT and innovative classroom practices. In R. B. Kozma (Ed.), *Technology, innovation, and educational change: A global perspectiva* (pp. 43-80). Eugene, OR: International Society for Educational Technology.

Laferrière, T. (2005, August). *Pre-service teachers' use of Web-based environments to support field experiences, collaborative reflective practice and knowledge building*. Paper presented at the Annual Meeting of the European Association for Research on Learning and Instruction (EARLI), Cyprus.

Laferrière, T., Breuleux, A., & Erickson, G. (2004). Telecollaborative communities of practice in education within and beyond Canada. In A. Brown & N. Davis (Eds.), *World yearbook of education 2004: Digital technologies, communities and Education* (Chapter 17). London: RoutledgeFalmer.

Lave, J. & Chaiklin, S. (Eds.). (1993). *Understanding practice: Perspectives on activity and context*. Cambridge: Cambridge University Press.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lawley, E. (1992). *Discourse and distortion in computer-mediated communication*. Retrieved May 12, 2006 from http://www.itcs.com/elawley/discourse.html

Lee, E. Y. C., Chan, C. K. K., & van Aalst, J. (2006). Students assessing their own knowledge advances in a knowledge building environment. *International Journal of Computer-Supported Collaborative Learning, 1* (1), 57-87.

Lemonnier, F.-H., Gagnon, O., Huot, D., Hamers, J., & Parks, S. (2001). L'utilisation des TIC influence-t-elle l'aspect général des productions écrites en anglais langue seconde chez des élèves du secondaire? In F. H. Lemonnier & L. Duquette (Dir.), *Impact de l'utilisation de l'ordinateur et des nouvelles technologies dans l'apprentissage des langues* (pp. 125-152). Montréal: Les Cahiers Scientifiques de l'Acfas 97-Association Canadienne-Française pour L'Avancement des Sciences.

Lieberman, A. (2000). Networks as learning communities: Shaping the future of teacher development. *Journal of Teacher Education, 51* (3), 221-227.

Lieberman, A. & Grolnick, M. (1996). Networks and reform in American education. *Teachers College Record, 98* (1), 7-45.

Littleton, K. & Light, P. (1999). *Learning with computers: Analysing productive interactions*. London: Routledge.

Littleton, K. & Whitelock, D. (2005). The negotiation and co-construction of meaning and understanding within a postgraduate online learning community. *Learning, Media & Technology, 30* (2), 147-164.

McLoughlin, C. & Oliver, R. (1998). Maximising the language and learning link in computer learning environments. *British Journal of Educational Technology, 29* (2), 125-136.

McCormick, R. (2004). Collaboration: The challenge of ICT. *International Journal of Technology and Design Education, 14*, 159-176.

Ménard, L., Allaire, S., McLelland, J., & Laferrière, T. (2003, August). *Knowledge building in peer tutoring: 9th graders deepened their understanding of and improved their practice.* Poster session presented at the IKIT Summer Institute 2003, Toronto, Canada.

Nizet, I. & Laferrière, T. (2005). Description des modes spontanés de co-construction de connaissances dans un forum électronique axé sur la pratique réflexive. *Recherche et formation, 48*, 151-166.

Orr, J. (1996). *Talking about machines: An ethnography of modern job*. Ithaca, NY: IRL Press.

Partenariat PROTIC-FCAR-TACT. (1999). *Gestion d'une classe, communauté d'apprentissage: Phase 1 du projet de recherche*. Québec: Équipe TACT, Université Laval.

Partenariat PROTIC-FCAR-TACT. (2000). *Gestion d'une classe, communauté d'apprentissage: Phase 1 du projet de recherche*. Retrieved July 12, 2005 from http://www.tact.fse.ulaval.ca/fr/html/fcar/rapporta.html

Partenariat PROTIC-FCAR-TACT. (2001). *Gestion d'une classe, communauté d'apprentissage: Phase 1 du projet de recherche*. Retrieved July 12, 2005 from http://www.tact.fse.ulaval.ca/fr/html/fcar/gestion2001.pdf

Putnam, R. T. & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29* (1), 4-15.

Roschelle, J. & Teasley, S. (1995). The construction of shared knowledge in collaborative problem-solving. In C. O'Malley (Ed.), *Computer Supported Collaborative Learning* (pp. 69-97). Berlin: Springer-Verlag.

Salomon, G. (Ed.). (1993). *Distributed cognitions: Psychological and educational considerations*. New York: Cambridge University Press.

Scardamalia, M. & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences, 3* (3), 265-283.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Strike, K. & Soltis, J. F. (1998). *The ethics of teaching*. New York: Columbia University, Teachers College.

Theureau, J. (2004). L'hypothèse de la cognition (ou action) située et la tradition d'analyse du travail de l'ergonomie de langue française, *@ctivités, 1* (2), 11-25. Retrieved September 12, 2006 from http://www.activites.org/v1n2/theureau.pdf

Thompson, A. D., Schmidt, D. A., & Davis, N. E. (2003). Technology collaboratives for simultaneous renewal in teacher education. *Educational Technology Research and Development, 51* (1), 71-87.

Vygotsky, L. S. (1978). *Thought and language* (A. Kozulin, Trans.). Cambridge: Cambridge University Press. (Original work published in 1934).

Wegerif, R. & Mercer, N. (1997). Using computer-based text analysis to integrate qualitative and quantitative methods in research on collaborative learning. *Language and Education, 11* (4), 271-286.

Wenger, E. (1998). *Communities of practice. Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Wertsch, J. V. (1979). From social interaction to higher psychological process: A clarification and application of Vygotsky's theory. *Human Development, 22*, 1-22.

Acknowledgements

We wish to extend our thanks to the students, teachers and administrators of the school where this design program was carried out. We are particularly indebted to the teachers and student teachers who negotiated meanings throughout the duration of these experiments.

[1] The sending of e-mail messages and accessing information on websites can hardly be considered here as basic. Advanced online collaborative tools have affordances that support, among others, meaning negotiation and knowledge building among peers or colleagues.

[2] Funding for the networked community was provided by the TeleLearning Network of Centres of Excellence (Canada). The R & D project was entitled TACT: A virtual community of support and communication for pre-service teachers.

[3] At the theoretical level, the emergence of the situated cognition perspective (Brown, Collins, & Duguid, 1989; Greeno, Collins, & Resnick, 1996; Lave & Wenger, 1991) also provided a rationale for innovation in teacher education. This perspective emphasized that the teacher-learning context, be it physical or social, was to be considered part of the activity itself (see Putnam & Borko, 2000).

[4] Each partner respected the "control zone" of the other, that is, each other's classroom management.

[5] An hybrid environment combines on-site and on-line interaction for learning purposes.

[6] See also other researchers for whom quality of learning is associated with meaning negotiation (e.g., in the francophone world, Gilly, Roux, & Trognon, 1999), and especially those who study the use of the networked computer to this end (Littleton & Light, 1999; Littleton & Whitelock, 2005; McLoughlin & Oliver, 1998; Wegerif & Mercer, 1997).

[7] The school hosted over 40 student teachers. Student teachers doing early field experiences and student teaching in PROTIC classrooms were regrouped rather than dispersed according to their level of advancement in their four-year program.

[8] The authentic problems raised by student teachers regarded their own practice of becoming effective teachers in a networked classroom, and contrasted with the discourse of previous years (e.g., the role of the teacher as a guide; the establishment of a learning community; face-to-face and on-line discourse, metacognition). Their cooperative teachers were stepping aside from the traditional transmission role in the classroom, and they were hearing them referring to the learning community concept in face-to-face conversations.

[9] Funding for this project was provided by the *Fonds pour la Formation de Chercheurs et l'Aide à la Recherche* (FCAR), reference 98-NT-0028. FCAR was considered a partner in the project as it had set a new research program to study the use of ICTs in Quebec classrooms.

[10] Meso-level analysis have been conducted and communicated since 1997. For micro-level analyses, see (Nizet & Laferrière, 2005; Laferrière, 2005; Campos, Laferrière & Lapointe, 2005).

[11] The three conditions for educational change according to Fullan (1993) are knowledge, support and pressure.

[12] The minimal definition of the “networked classroom” is one that has at least one computer connected to Internet.

[13] Berners-Lee (1999) and colleagues developed the Web for information access and as a support for collaboration.

[14] Any platform, be it WebCT, Blackboard, Moodle or another, presents affordances and constraints. Therefore, its choice affects the design and practices of a given community.

[15] The Knowledge Forum platform, whose design continues to be informed by contemporary cognitive science research, offers to its users an increasing number of learning and knowledge building artifacts, some are public and others restricted to specific knowledge building communities.