Teacher education in the networked classroom

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Abstract

The purpose of this paper is to delineate the role of teachers/educators in networked classrooms. Firstly, we present how the teachers' primary workplace is changing, moving from the traditional isolated to the networked classroom. Secondly, we point to how teachers and learners' roles are shifting: a networked classroom calls upon the teacher's competence to direct or facilitate learning through both face-to-face and on-line interaction with students. Thirdly, teacher education design experiments in networked classrooms are briefly presented. Fourthly, we suggest a tentative framework of teacher education models supportive of Canada's innovation agenda.

INTRODUCTION

The networked classroom describes the workplace of an increasing number of teachers. In Canada, the effort to network schools and classrooms began nearly a decade ago. Hardware and software, capable of handling text, image, sound, and video, were deployed. Improved school technology became associated with the idea of a knowledge society and a global economy. To counterbalance business-type interests, the Canadian Teachers Federation advocated prudence, and stressed the diversity of children's needs, and the advantage of a better teacher/student ratio. Today, while connecting schools and classrooms (Internet and intranet) is still unfolding many teachers are experimenting with computer-supported pedagogical practices, wireless devices and handheld computers. Innovative settings demonstrate powerful results (McGillis, 1994; Bracewell *et al.*, 1998; etc.), and present educators with issues of implementation, sustainability and scalability.

Provincial departments of education are engaged in the process of revising learner expectations regarding thinking, social and technology skills (Alberta Information and Communication Technology Curriculum, 2000; Learner Expectations and Assessment, Ontario Knowledge Network for Learning, 2000; Quebec Education Reform, 2000). In its recent report to the Minister of Education, the Conseil supérieur de l'éducation of Quebec (2000) insists on the pedagogical dimension of ICT integration into the curriculum. Different theoretical perspectives such as constructivism and socioculturalism have also been used to justify the integration of ICT in teaching and learning. The Delors' Report[1] (1996), that emphasizes work skills, is quoted to justify the integration of information and communication technologies in education.

The contribution of information and communication technologies to teaching and learning is increased when the teachers' pedagogy engages learners in authentic problem solving and deep understanding (Bracewell *et al.*, 1998). Advances in cognitive science provide a theoretical basis for engaging school learners in active and authentic ways (Resnick, 1987; Brown & Campione, 1994; Scardamalia & Bereiter, 1994; Bransford, Brown, & Cocking, 1999). Early positive results in the use of online resources and tools for learning and teaching that go beyond gains in basic technology skills point to more complex roles for teachers and learners (Haughey, 2000; Jefferson & Edwards, 2000; Daigle, 2001; McGhee & Kozma, 2001[2]). And so it is imperative that schools' technology integration plans include new modes of professional development, as well as equipment and technical support. Schools that show an increased awareness of the importance of lifelong-learning skills and deeper understanding of subject matter in primary and secondary schools need the support of their colleagues and of local and provincial educational policy makers (Lieberman & Miller, 2000; Anderson & Dexter, 2000). Teacher preparation programs that encourage thoughtful and effective integration of information and communication technologies are also required. Otherwise, schools' overt curriculum may change, but its hidden curriculum is likely to keep targeting conformity instead of creativity, individual-competitive rather than collaborative learning skills, and tradition rather than innovation. Assessment and evaluation procedures developed to meet the public demand tend to narrow the curriculum when most teachers respond by teaching to the test (Knowledge Forum Summer Institute's participants, 2000, http://kf.oise.utoronto.ca/si2000poster/index.html).

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1 Report of the International Commission on Education, UNESCO.

2 McGhee and Kozma report on the U.S. 12 case studies of the Second Information Technology in Education Study (SITES-M2) conducted by the International Evaluation Association (IEA). The Canadian Report on which two of the authors of this paper are working is in progress.

The assumption of this paper is that a new socio-technical infrastructure for teaching and learning is unfolding[3], thus carrying with it some gains and losses as all significant incremental or transformative changes tend to do. Here we focus on the importance of teachers and learners engaging in more adventurous and beneficial learning projects and tasks during school hours. We discuss four issues:

1. The networked classroom (an elementary, a secondary, or a post-secondary classroom) as a working place.

2. The roles of teachers and learners in classrooms reconceptualized as knowledge-building communities.

3. Teacher education design experiments combining face-to-face and online interaction, designed in Canadian universities and schools.

4. A distributed comprehensive framework presenting innovative options for teacher preparation and professional development.

Networked classrooms

For the purpose of this paper, a broad definition of the networked classroom is adopted to include those where learners have either low- or high-access to the Internet (and/or intranet) at any point throughout their schooling experience. But there is more to the networked classroom than basic electronic connectivity. Elementary, secondary, and post-secondary schools are integrating information and communication technologies into teaching and learning for practice renewal purposes. An increasing number of classrooms that are now equipped with a permanent connection to the outside world, allow connections in either direction. Pelgrum and Anderson (1999), Becker (2000a), and others all demonstrate the breadth of the phenomenon.

The directionality of connections between the class and the outside world becomes worth considering when related to classroom processes and learning outcomes. Emerging communicative practices not only expand the class beyond its walls, but question the order of roles and processes in K-12 education. Depending on the teacher's beliefs, values, knowledge, and skill, the class takes advantage, to a greater or lesser degree, of the networked classroom as a learning place. Seven modes are identified (Breuleux *et al.*, 2001):

1) **The broadcast mode.** A one-way connection is established from the outside world into the class, and the networked computer is more or less used as a TV by the teacher for just-in-time lessons (Owston & Wideman, 1998).

2) **The interactive-tutor mode.** The connection is patterned in a pre-organized way to respond to a student's request, and the response is more or less adaptive. The computer is rather used as a CD-ROM or a textbook (The Learning Equation's Math Grade 9th, see Macnab, & Fitzsimmons, 1998).

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[3] In 1995, the TeleLearning Network of Centres of Excellence (TL-NCE) became part of this infrastructure. The authors' research has been supported by this Network since its inception, and they acknowledge both the financial and theoretical contributions of TL-NCE in research projects that led to the preparation of this paper.

3) **The classroom-project mode.** Connections are established both from the outside world into the class, mainly in response to requests by students participating in a project, and, from the class to the outside world in the course of producing the project and publishing it on the Web (Judy Harris, 1998; Hyper Studio Teacher Community, GrassRoots Program at SchoolNet Canada, http://www.schoolnet.ca/grassroots/e/index.asp).

4) **The daily-newspaper mode.** The connection is initiated from the class to the outside world, and the classroom website publishes on the Web what used to be communicated within walls (http://www.protic.net).

5) **The simulation mode.** A connection is established from within, through a request from the teacher who wishes to demonstrate or illustrate a specific principle, a difficult notion or a social practice during a presentation to the whole class or a small group, and then the connection goes from outside into the class. The connection may also be established at the student's request (http://can.brainium.com).

6) **The collaborative-space mode.** Connections are highly bi-directional to create a virtual collaborative space to work on creating a conceptual artifact (an idea, a theory or a knowledge new to the community) through knowledge transforming discourse in both face to face and on line discussions supported by a multimedia collaborative design space (e.g., Knowledge Forum®).

7) **The collaborative knowledge building mode.** Connections are highly bi-directional and involve the use of a virtual collaborative space creating, a conceptual artifact (an idea, theory or knowledge new to the community) through knowledge transforming discourse in both face to face and on line in a multimedia collaborative design space (e.g., Knowledge Forum®, CSCL, CSILE: http://csile.oise.utoronto.ca).

The application of the above-identified modes is on the increase. Adaptation to the learner's needs in a context of increased student diversity, and flexibility of approaches for the lifelong learner are important to many educational actors. The networked classroom presents itself (see the notion of co-constitutionality in phenomenology) with a greater variety of learning activities. Classroom processes such as communication, decision-making, inquiry, knowledge building, and role taking largely depend on the teacher's pedagogy in the networked classroom (Bracewell, Breuleux, & Le Maistre, in press; Caswell & Lamon, 1998; Haymore Sandholtz, Ringstaff, & Dwyer, (1997); Laferrière, 2000; Reeve & Lamon, 1998; Owston, 1998; Scardamalia & Bereiter, 1996; Schofield, 1998; etc.). Well-informed, imaginative, and creative teachers know how to organize time, space, and resources and engage students in challenging learning tasks. Integrating networked technology into teaching and learning makes the teacher's role even more complex.

Teachers and learners' roles

In a study of national scope, Ravitz, Becker, and Wong (2000) indicate that 1) constructivist teachers use the Internet significantly more than traditional teachers, and 2) that more sophisticated software is used in high-achieving math classrooms while low-achieving classrooms use games more. In Canada, there is not yet a study such as the one available in the U.S., but TL-NCE Educating Educators Research Team also has evidence that the constructivist perspective[4] is reflected in the roles taken by the teacher and learners in networked classrooms. Some of our projects have documented these changes over the last five years in classrooms that are well equipped with ICT (e.g., networked multimedia computers with access to the Internet, and customary peripherals (printers, CD-ROMs, scanners, and cameras). Much of the academic activity of these classrooms looks quite different from a traditional classroom. To illustrate, vignettes of new practices observed in different schools in Canada are presented at the following Website (http://www.telelearning-pds.org/tlpds/theme7/roles.html). These vignettes point to some critical themes and issues likely to relate to successful implementation or not of those practices in specific schools. Specifically, the vignettes deal with student engagement in learning, the release of agency from teacher to students, and collaborative knowledge building around authentic or ill-defined problems. Here are a few excerpts:

Student engagement

> They decided they wanted to build a castle and so… I said I'll get a cardboard box and the next thing we know our whole classroom was created into a three-dimensional castle with the working draw bridge and the round table. So our whole mathematics was done through that. Through the building of the castle. The kids did their research using the Internet, using books, using older students to help scribe some, to do a little bit of keyboarding for them. But for the most part, it was very much their work. And at the end of the year, they did an exhibition of their learning, and they created the script too.

Authentic learning

> Divisés en six groupes (fonctionnaires, industriels, ingénieurs, environnementalistes, amérindiens et pleinairistes) qui représentent les utilisateurs et les défenseurs de la forêt, les élèves disposaient d'une quinzaine de jours pour se préparer à un débat au cours duquel ils devaient faire valoir leur position quant aux problèmes et enjeux entourant la préservation de la forêt au Canada.

Re lease of agency

> The students were working in groups at the computers on projects in science and social science. The teacher was moving from group to group, assessing progress and offering suggestions on what resources to access. One of the students was working on a project on the physical geography of Europe and the teacher suggested that he prepare a map showing the major mountain ranges.

[4] Piaget pointed to the importance of action for the development of the knowing subject (1936, 1947). Cognition is *productive action* able to promote structural changes in a system, creating history either by aggregating a pre-existent world of meanings in continual development or by creating a new one as a result of that history (Piaget, 1992; Varela, 1988). However, action is situated in a social-cultural environment, and that recursively shapes its own structure. As one TL_NCE researcher puts it, our colleague Carl Bereiter, "Stripped to their essentials, constructivism tells us to pay close attention to the mental activities of the learner and socioculturalism tells us to pay close attention to cultural practices in the learner's milieu."

> (….) the student takes the initiative for most of the interaction and this is facilitated by the teacher, indicating an acknowledged sharing and division of responsibility for academic work.

Collaborative knowledge building

> In a knowledge building classroom, students integrate their individual interests by selecting their own books to investigate and work collaboratively with other students to understand the perspective of the genre.
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> Ashley's summary of her book gave rise to 27 responses from other students. Many of these were questions that raised the depth of analysis from the content of the book to ideas about religion, magical realism, and explanations about causality.

Instead of the teacher organizing student learning activity, either directly through didactic instruction or indirectly through student seatwork, we see a distributed organization of student learning with the students themselves taking on more responsibility for their learning. The management of this activity is supported by a number of factors: The release of agency by the teacher, the assumption of agency by the students, the training of the students in cooperative/collaborative learning and their application of these skills to make progress in their academic work, the freeing of the teachers' time to allow individual and group consultation, the integration of formative assessment and learning so that the former can guide the latter, and, finally, access to information and communication technologies that allow the students to be more independent and productive. It is the confluence of all these factors that realize the effective use of the technologies. (Bracewell, Breuleux, & Le Maistre, in press; Bracewell & Lajoie, 2000)

These changes describe a radically different classroom situation from the traditional one for both teachers and students, one in which participants' roles (i.e., who is instructing) vary from time to time and from person to person, in which participants' responsibilities and expectations are much more elaborated and varied, and in which knowledge and expertise is shared across teachers and students. In particular, the teachers' activities in fostering student learning emerge as very different in kind from those seen in the traditional classroom.

These findings come from a protected environment, however, in the sense that the teachers are volunteers with both interest and experience in teaching with ICTs, the work has the status of being a special and recognized initiative, and the classrooms are supported by funding and technical help from university-based research groups. An emerging issue with respect to the effective use of ICTs in classrooms is that of scalability: How will these effective practices move into classrooms that are not protected, where teachers are not as enthusiastic or knowledgeable about ICTs, where the expectation that teaching with ICTs is routine, and where help with ICT resources is the responsibility of the school? Blumenfeld, Fishman, Krajcik, and Marx (2000) and Fishman (2000) call for a 'systemic' approach to issues of scalability, one which takes account of context in terms of existing policy and management practices of schools and boards, in terms of the capability to implement and sustain innovations (e.g., professional development resources, technical resources), and in terms of the culture of teachers and schools (e.g., teaching and evaluation philosophies and practices).

Awareness of the significance of these contextual factors is leading researchers to take a more sophisticated theoretical approach to the implementation of effective practices with ICTs in teaching and learning. We use Activity Systems Theory (AST) (Cole & Engestöm, 1993; Engeström, 1987) to analyze the emerging roles of teachers and school learners and the processes that will be needed to

realize these new roles, and explain why some practices involving information and communication technologies may take off in a school and why others may never get underway (e.g., Bracewell & Renaud, 2001). The basic constructs of activity systems theory[5] help us to identify components of existing and proposed practices, and thus serve to spotlight potential facilitators and obstacles for new practices using ICTs.

Collins (1991) pointed to a number of shifts that teachers, including teacher educators, must first accept before they can competently integrate technology into their practice. They were: 1) a shift from whole class instruction to small group instruction; 2) a shift from lecture and recitation to coaching; 3) a shift from working with better students to working with weaker students; 4) a shift toward more engaged students; 5) a shift from assessment based on test performance to assessment based on products, progress, and effort; 6) a shift from competitive to cooperative social structures; 7) a shift from all students learning the same thing to different students learning different things; and 8) a shift from the primacy of verbal thinking to integration of verbal and visual thinking (pp. 29-30).

For the past decade, constructivist researchers working mainly in science and mathematics education have provided examples showing (1) teachers skillful in managing dialogue in which the students take a highly active role, (2) students become seriously concerned with understanding, and (3) evidence, over the span of the episode, of some progress in students' conceptual understanding (Driver, Asoko, Leach, Mortimer, & Scott, 1994; Cobb, 1994). When the teacher sees the learner as an inquirer (Bruer, 1994; Marx, Blumenfeld, P. C., Krajcik, & Soloway, 1997) and when the classroom as a whole is reconceptualized as a knowledge-building community (Scardamalia & Bereiter, 1994) or a community of learners (Brown, 1997; Bransford, Brown, & Cocking, 1999), the networked classroom becomes a seamless part of the learning environment.

> In the twelve U.S. exemplary cases of the SITES-M2 study, McGhee and Kozma (2001) note: Although teachers retained many of their traditional roles (e.g. class leader or director, lecturer, discussion leader), they negotiated multiple new roles in classrooms that utilized innovative technology-supported practices. The new teacher roles we identified were instructional designer; trainer; collaborator; team coordinator; advisor; and monitoring and assessment specialist. (p. 23)

As important as exemplary practices may be for practitioners, researchers and policy makers, issues of sustainability and scalability are next in the minds of those who know what thoughtful and skillful teachers can do for student learning in networked classrooms. Cuban (2000), an oft-times critic of technology in education, points out that for computers not to be "oversold and underused", substantive and enduring teacher professional development and technical and administrative support are key (also see Becker's (2000b) discussion of competing philosophical viewpoints about teaching).

The assumption of this paper is that constructivist teachers (new role) who encourage students to be self directed learners, team members, and knowledge builders (new roles)[6] and knowledgeable about ICTs (new tool) are required for technology to deliver on its promise of preparing participative citizens

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[5] How the individual interacts with the environment ('doing alone') becomes mediated by the tools developed to enhance action; the interaction of the population with the environment ('doing together') becomes mediated by division labor as groups set up complementary roles for accomplishing different parts of a task; and interaction of the individual with the population ('being together') becomes mediated by rules and norms of communication and social interaction. The evolution of society is characterized by 'ruptures' along each of the direct lines of relationship between the initial components, such that the relationships become mediated by technical, social, and communicative constructs.

[6] The three school learners' roles that are emerging from the twelve SITES-M2 U.S. case studies, as reported by McGhee and Kozma (2001), are the following ones: self-learner, team member, and knowledge manager.

and knowledge workers (new role). However, these new roles and tools are still much debated. "The old norms of individualism, isolationism, and privatism", as pointed out by Lieberman and Miller (2000) and Lortie (1975), "no longer suffice; teachers need to develop new ways of doing business and of viewing themselves and their profession." (p. 51). New norms, rules and tools that would indicate a rupture from traditional teaching are only at best emerging (see also Tardif, 2000). Besides, there is another view of the networked classroom, one linked to that of a de-skilled teaching profession precipitated by new technology, that must also be considered. The Canadian Teachers Federation (CTF, 2001; Moll, in press) has been most sensitive to this issue. The prospect of a de-skilled teaching profession was already a concern of a Pan-Canadian group of educators who developed a Vision statement of Learners in the XXIst Century (Henchey *et al.*, 1996). Contributive factors include the shortage of teachers, the soaring cost of health services in provincial budgets, the growing diversity of the needs of children and adolescents, the increased demand for education[7], and the large number of teachers (over 300 000) that need suitable professional development.

The first and second modes of interacting in the networked classroom, the broadcast mode and the interactive-tutor mode, lend some credence to the de-skilling teacher profession view. When a one-way connection is established from the outside world into the class, one networked computer is enough to provide just-in-time lessons to students. "Cable in the classroom" activities may come in handy to the teacher who knows how to engage students in meaningful learning tasks, but they may also be playing a substitute teacher. The same is possible with the interactive-tutor mode. We know that the interactive capacity of the computer (new tool) keeps increasing, and that engaging learning activities are becoming more and more a reality (new norms?). The role of the teacher then is to make such activities meaningful for students while integrating them into the class curriculum.

Expressions such as "learner-centered" and "anytime-anywhere-anything" convey the meaning that individual learning is feasible inside and outside the classroom. Barker's and Wendel's (2001) comments on Canadian virtual schools as a second chance opportunity are most informative in this regard. Processes such as the de-synchronization of the classroom and de-localization are now becoming more visible to the teaching profession and to the greater public. Teachers take on new roles such as online publisher, online moderator, or team member in online course development. Learning communities exchange artifacts and research data and interpretations. Parents are empowered to think of home schooling. For teachers not to fade away in the presence of powerful networked computers, but to use them to benefit school learners and lifelong learners to be, there must be coherent teacher preparation and professional development programs, ones inclusive of ICTs.

Therefore, we turn to learning to teach with ICTs in response to what we perceive to be a systemic need for content and process renewal along the teacher professional development continuum.

Teacher education design experiments

The most recent revision of the definition of teacher competence in Quebec includes one element regarding ICT integration to teaching and learning. Nothing compares, however, to The California Commission on Teacher Credentialing which adopted new technology standards for credential candidates[8], or to the national teacher education curriculum standards for ICT in the UK[9].

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[7] Nearly 70% of all new jobs in Canada require a university degree, and learning is now regarded as a lifelong process (Delors, 1996).

[8] See http://134.186.81.70/codcor.doc/999916/999916.html#COMMON STANDARDS .

[9] See http://www.canteach.gov.uk/info/library/circular4-98/Annexi.doc.

This observation is based on a survey[10] of what provinces are requiring teacher candidates to demonstrate in order to qualify for certification. Most pre-service teacher education programs in Canada are not required to meet any agreed upon ICTs standards. However, many teacher educators in faculties of education are experimenting with information and communication technologies[11]. We think there are three dimensions to teachers' professional knowledge and skills which are needed to use ICTs successfully: Technical knowledge, pedagogical knowledge, and pedagogical content knowledge.[12]

In the TL-NCE research program, we engaged in innovative teacher education practices that integrate technology and pedagogy. Aiming that teachers would use new tools in order for students to learn in a more engaged, authentic, intentional and collaborative way (new roles, norms and rules of interaction), we conducted design experiments (Brown, 1992; Collins, 1999) with pre-service teachers and in-service teachers. Brief case studies are hereafter presented, using the AST framework.

In Western Canada, **CITE** (**Community of Inquiry in Teacher Education**) is a networked community of inquiry at the University of British Columbia (UBC) that operates along the cohort model. CITE[13] is related to three nested communities of practice. These communities of practice include the school-based educators, the campus-based teacher educators, and the cohort of about 36 pre-service teachers[14]. Up to now, ICTs have primarily been used to create a structure that helps integrate program components and connect student teachers and university and school-based teacher educators involved in these different program components (AST: new tools). For example, course documents, schedules, events and assignments are published on a web-site and all program participants have access to this material. The second phase of the research involves the design of specific pedagogical practices using web-based and hypertextual media. Examples of these practices include the use of on-line discussions, contributions to electronic journals and web-based presentations and assignments (AST: emerging rules of interaction).

The most successful CITE approaches have been to a) develop community support and understanding of technology initiatives through discussions at weekly team meetings; b) provide easy access to technological tools through weekly lab periods where technical support was available; c) demonstrate the value of technology-enhanced practices when pre-service teachers incorporated technology-mediated learning activities in the practicum; d) create curricular spaces for technology lab time by re-defining aims of an existing communications course; e) incorporate a technology resource person to work individually with the team members on developing strategies for curricular integration.

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[10] Teacher certification ICT standards or other related criteria were inquired for through phone conversations and face-to-face consultations with relevant governmental, professional and post-secondary organizations.

[11] In the first *Handbook of research on teacher education*, Brooks and Kopp (Houston, 1990) pointed to the responsibility of teacher educators to experiment with technology. Steps were taken in this direction in Canadian faculties of education. Shapson and Owston (1999) identified their exemplary practices and models of the use of ICT.

[12] We refer the reader to the following url at which we provide some basic information on teacher competence in the use of ICT: http://www.telelearning-pds.org/tlpds/theme7/tcomp.html .

[13] For a description of the features and objectives of the CITE program go to: http://www.educ.ubc.ca/courses/cite

[14] While some might argue that the pre-service teachers do not constitute a unique community of practice since they are only together for one year and they are being prepared to enter a 'teaching' community of practice, we wish to argue that in the context of the program these three communities engage in quite different social practices, have somewhat different sets of goals and values, and have very different reward structures that influence their beliefs, attitudes and activities.

The challenge will be to develop comparable activities and structures in the school environment as we shift our focus to working collaboratively with our school-based community members (AST: new roles, norms and rules).

The **KNOWLEDGE-BUILDING/KNOWLEDGE FORUM®**[15] project at the Ontario Institute for Studies in Education of the University of Toronto is a cross sector community of students, teachers, researchers, social and community groups, and small businesses. The goal is to create and sustain a knowledge society network where knowledge creation in one primary group advances the progress of other groups. Scardamalia (2000) has termed this symmetric knowledge advancement a design experiment where participants are willing to test new pedagogical models and to be part of open, research-intensive online communities. Participants are involved because of shared problems of understanding, rather than segmented on the basis of sector, age, or research community (AST: new tool use, emerging roles, norms and rules of interaction).

In one line of research, we focused on the interactions between teachers, researchers, pre-service teachers and elementary students. The knowledge-building work of elementary students served to advance the learning of pre-service teachers in two ways (Lamon, Reeve & Caswell, 1999). First, pre-service teachers came with an initial view of teaching and learning based on their own schooling. Most of their perspectives were based on a transmission model of learning where the teacher's own knowledge circumscribes what students will learn. By observing the Knowledge Forum® discourse among elementary students in a knowledge-building classroom, the pre-service teachers began to construct a new model of schooling where teaching and learning for understanding is primary (AST: emerging roles, norms and rules of interaction).

Second, pre-service teachers created their own knowledge building community. They worked on a dilemma of understanding related to the problems that elementary students were also tackling affording them the opportunity to build their own knowledge and to appreciate the conceptions elementary students bring to science. Thus, they observed and discussed with practicing teachers how to use knowledge building in the service of learning. At the same time, classroom teachers and students improved through pre-service teachers' reactions to classroom Knowledge Forum® databases. Many teacher inventions for improving their own classroom practice have stemmed from pre-service teachers' observations of their classroom databases (AST: new roles and rules of interaction).

The digitally stored output of these online communities is open for investigation by other participating communities (AST: emerging tool use). (To virtually visit Knowledge Forum® databases please go to http://kf.oise.utoronto.ca/VirtualTours/ .)

TACT is a Francophone learning community based at the Laval University/Quebec City site. There is a range of interaction modes with its most advanced, authentic context integrating online activities in a school-within-a-school program (PROTIC) located in a large, secondary school 6 miles from Laval University's main campus. The learning community members associated with this school are studying the thoughtful integration of ICTs in their professional practice (AST: emerging tool use, roles, and rules of interaction). TACT is also the acronym of the interactive Web site named Technology for Advanced Collaboration among Teachers/TéléApprentissage Communautaire et Transformatif. Learning activities are conducted within and between classrooms, reconceptualized as learning

[15] Knowledge Forum® is a second generation CSILE (computer supported intentional learning environments) product. The software allows users to create a knowledge-building community. Each community creates their own database in which they can store notes, connect ideas, and "rise-above" previous thinking. The note-taking, searching, and organizational features of this sophisticated tool allow any type of community to build knowledge. The software is available for both a local area network and over the Internet. For more information please visit www.knowledgeforum.com.

communities. University students at all levels at times participate as mentors or experts for members in other learning communities.

The online collaborative tools in use are Virtual-U VGroups platform, and Knowledge Forum®. The first is used to support learning and research activities (information-gathering, topic discussions, project-based collaborative learning, collaborative journal writing (early field experiences), collaborative reflective practice now integrating video clips into discussion forums (student teaching), and other collaborative knowledge building activities such as case-study writing (emerging roles and rules of interaction (see Breuleux, Laferrière & Bracewell, 1998; Legault, 2000; Laferrière, 2000). The pre- and in-service teachers report feeling part of a larger community of teacher learners (TACT), and have developed a sense of being co-researchers. WebKnowledge Forum supports the development of a critical mass of early-adopter practices (l'ABC_W), from using this collaborative space as a bulletin board, an animated multimedia space as well as a space to record the conduct of students' cooperative inquiries (Jigsaw structure) that may also engage students from different classes (emerging tool use). On the PC French version of Knowledge Forum, available since February 2000, over ten learning projects have been conducted. Middle-school classrooms have written over 1500 notes on specific topics, problems, and hypothesis testing (emerging norms and rules of interaction).

These tools also support reflective collaborative practice and other knowledge-building activities such as ethnographic inquiries into the artifacts produced by student teachers from a previous year or from another school. During student teaching, the learning community becomes an emerging community of practice, members interacting face-to-face and on-line for the sake of learning, and among others, how to integrate ICTs in project-based collaborative learning. Case writing (e.g. classroom organization and management in networked classrooms) is another advanced practice, which is useful not only to the author of the case study, but to other members of the community of practice (new roles). See http://www.tact.fse.ulaval.ca .

McGill TL•PDS Net. The community of learners related to McGill University has a diversified membership made of teachers from at least ten schools actively engaged in the integration of ICTs, and whose most advanced online collaborative practices are of an interpretative nature. At the local level, they are developing a practical understanding of on-line discussion and information tools (AST: emerging tool use).. For example, 70 student teachers and practicing teachers in the McGill TL•PDS Net have engaged actively in web-based electronic discussions during, and following, the 2000 Summer Institute: they have exchanged over 700 messages from August to January. The messages served a variety of purposes such as information sharing, interpersonal support, team building, and knowledge building. These educators also are learning in practical and experiential ways how on-line, knowledge-building communities are formed, and what such communities can achieve. For example, teachers in five schools of the McGill TL•PDS Net created, and are monitoring, their own on-line groups for students and/or colleagues. Therefore, there is an emerging practice of on-line collaboration that extends learning in powerful ways, but most importantly there is a growing ownership of the tools, with an associated sense of efficacy on the part of the teachers.

The McGill TL•PDS Net has established a design team composed of a cross section of teachers, student teachers, and faculty members; through meetings and on-line discussions they are developing the next iteration of the Phase I and Phase II Summer Institute for returning participants in August 2001. Phase II allows practicing teachers who have already achieved a certain familiarity with digital networks in their class to develop advanced uses of the technology. These advanced uses concern mostly: a) achieving a more systematic integration of ICTs in the new reformed curriculum[16], b) using ICTs to

[16] This refers to the specific local context of the curriculum reform engaged by the Quebec Ministry of Education (see http://www.meq.gouv.qc.ca/virage/m_ques_rep.htm).

support advanced pedagogies such as collaborative knowledge-building and, c) teachers becoming leaders on issues of ICT integration in their school or school board (new roles). The research team is expanding to include more participation by practitioners; one current project involves collecting and assembling a series of "cases", based on the experiences of lead teachers, and preparing a case-discussion web-site for the on-going interpretation of emerging practices (AST: new roles and rules of interaction). This phase develops and documents new socio-technical processes for communities of reflective educators to identify, capture, organize, and interpret moments from the networked K-12 classroom, where advanced pedagogies, collaborative knowledge building, and technology integration are combined into emerging practices and constitute the focal point of inquiry for the participants. For instance, the McGill TL•PDS Net is exploring how a range of "recording" tools and shared interpretation spaces (portable notebook computers, digital video camera, high-speed Internet access; shared web-site, collaborative knowledge building tools) can empower teachers to engage in digital "story-telling" within an interpretive community to capture critical events from the circumstances of practice (emerging tool use and rules of interaction). The teachers in that setting engage in reflective acts where recording and gathering artifacts is critical to their inquiry goals, organizing them for sustained interpretation with others, producing multiple diverging or converging interpretations. Practitioners as well as researchers thus are signaling to each other their emerging practices and the questions they have about these practices in order to engage in a process of interpretation. This activity is at the intersection of, on the one hand, narrative-based reflective practice (see Ricoeur, 1983, 1990) and, on the other hand, "case-studies" or case-based learning. Digital media supports the "story telling", the interpretation is using varied online synchronous and asynchronous tools for collaborative knowledge building. This project is grounded in, and requires, existing networked communities of practitioners and researchers, in a relation of trust, sharing common inquiry goals (see http://www.education.mcgill.ca/olit/institute).

A distributed comprehensive framework

Teaching and learning in networked classrooms is a rapidly emerging reality in Canada (Daigle, 2001). We have argued that the solution of choice is teacher preparation and professional development conducive to developing a deep understanding of authentic or ill-defined problems and lifelong-learning attitudes and skills for school learners. We have also argued that there are issues of sustainability and scalability as far as innovative practices supported by information and communication technologies are concerned.[17]

The dynamic that causes activity systems to change and evolve is assumed to be contradictions (Cole and Engeström, 1993). These include old and new tools, well-established and emerging roles, and familiar and ground-breaking patterns of interaction. A critical factor that differentiates whether a practice is adopted and carried on depends on the similarity to existing practices (Bracewell & Renaud, 2001; Fishman, 2000). Important factors are teachers' interaction with the school they work at, its goals; teachers' use of non-digital tools, and the differentiation of roles in the school). Practitioners and policy makers interested in sustainable and scalable models are invited to build on innovative practices already in place in educational institutions, ones likely to be enhanced by the use of networked computers.

Innovative practices in teacher preparation and professional development evolving from university-school partnerships are the point of departure here for developing a comprehensive framework. A three-layer distributed model is suggested, one that is pushing the boundaries of

[17] Larry Cuban's (2000) submitted recommendations –some of which having nothing to do with technology as such– that may be, for the most part, applicable in Canada.

institutional roles and norms along the continuum of academic/formal ←→ experiential/informal learning:

1. Campus-based teacher preparation + practica in K-12 networked exemplary classrooms (e.g. The Knowledge-Forum Project and TACT)
2. School-based professional development + campus-based/web-extended institutes (e.g. McGill TL-PDS Net)
3. Online communities of practice (formally recognized when inclusive of all levels of expertise in a specific domain: school-based teachers, university-based teachers, pre-service teachers (e.g. CITE).

Each of our design experiments made advances at one of the layers of this model while participating in the delineation of the others. Moreover, reviews of innovative practices in teacher professional development in Canada (Laferrière *et al.*, 1999; Colgan, Higginsson, & Sinclair, 1999; Daigle, 2001), in the U.S. (Doubler *et al.*, 2000), in Europe (Davis *et al.*, 1997), and in Australia (Mitchell & Mitchell, 2001) show numerous initiatives on which to build from in order to explore and structure the possibilities of the networked classroom that most school learners, both teachers and students, will experience in the near future. See this work in progress at http://www.telelearning-pds.org/tlpds/theme7/cframe.html .

Both the possibilities and pitfalls of the networked classroom are still mostly uncharted. Innovation will not so much depend on traditional forms of professional development, but on co-operation and dialogue in networked communities[18]. Issues such as that of control and privacy are bound to become critical: information control, social control, and self-control will present new challenges as networked classrooms multiply, and connect to on-line resources and tools.

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[18] Michael Connelly and Jean Clandinin observe (2001, in press) observe: "The Ontario College of Teachers recently produced a document with official approval from the College's Governing Council entitled the *Professional Learning Framework for the Teaching Profession*. The document makes a distinction between *professional learning required in legislation* and *other opportunities for professional growth and development.* It is in the category of *other opportunities* where teachers are expected to show initiative and choice and where the boundary line between formal and informal inservice teacher education is blurred. Eight categories of *other opportunities* are listed: academic programs, research activities, professional networks, professional activities, mentoring and networking, professional contributions, learning through practice, and technology and learning. Some illustrations of the blurred areas listed are *serve on a local school community committee or school council* (professional networks), *share ideas and resources with other colleagues* (professional activities), *become involved in a mentoring partnership* (mentoring and networking), *join a listserve* (technology and learning)."

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