Integrating ICT's in teacher tr@ining: a challenging balance

Thierry Karsenti, PhD, Université de Montréal
Monique Brodeur, PhD, Université de Montréal
Colette Deaudelin, PhD, Université de Sherbrooke
François Larose, PhD, Université de Sherbrooke
Maurice Tardif, PhD, Université de Montréal

With the collaboration of:
Carole Raby, Yves Daniel Garnier, Claudia Gagnon and Mélanie Leblond

TRANSLATION

Abstract

The importance of information and communication technology (ICT) in education has been proven. For several years now, at increasing warp speed, university teaching has been coping with changing relationships to knowledge and has been plunged into the digital world of the Internet and e-learning (Karsenti and Larose, 2001). In the context of educating future teachers, can pedagogical integration of ICT be achieved despite the new problems facing faculties of education? The answer now appears self-evident as teacher education officials and instructors can no longer ignore ICT, at the risk of censure by future teachers, the education sector and the general public. The key factor is a better understanding of how this pedagogical integration of ICT—which adds value to the teaching-learning continuum—can be achieved. Do instructor practices have an impact on the practices of future teachers? Have the obstacles and factors linked to change and efficient pedagogical integration of ICT evolved in recent years? Are faculties of education meeting the professional development needs of future and practising teachers? These are questions we hope to address in this report, which strives to present a meta-analysis of existing research in the field, but is also based on research in progress.

I. BACKGROUND-PROBLEM

"The thirst for learning is the most important attitude that can be formed."
John Dewey (1938).

The importance of information and communication technology (ICT) has been clearly established. In addition to the major changes this technology introduces into most professional activities, ICT is driving major social change. Discourse on the new economy also reflects these changes in society: we hear increasing references to the knowledge-based society, the networked society, the learning society and the learning community. With the sweeping changes brought on by the arrival of ICT, most school systems have introduced the development of technological skills specifically into curriculum for the primary and secondary levels.

This change or evolution of curriculum raises the issue of pre-service and in-service teacher education. Of the five factors that influence implementation of technology, identified Fabry and Higgs (1997), three involve the human aspect: resistance to change, teacher attitudes and professional development. Professional development is defined here as a key component since a suitable program could influence attitudes and the resistance to change. Aware of the importance of teacher education, the Council of Ministers of Education, Canada (1997) made this issue a key priority with respect to the growth of technology in Canada.

For several years now, at increasing warp speed, university teaching has been coping with changing relationships to knowledge and has been plunged into the digital world of the Internet and e-learning (Karsenti and Larose, 2001). Many believe that teaching with or via technology is the most dynamic sector and the most popular in the education and university teaching market (Schutte, 1999). Brown (1996) also indicates that the most significant change in education is the phenomenal growth of the Internet, especially the graphic version commonly known as the Web. Both have changed forever the way we communicate, but above all, the teaching environment. In just a few years, the Internet and the Web have become for many people a virtually indispensable fact of daily life (Karsenti and Larose, 2001). For example, as revealed by a recent survey conducted in October 2000 by the Angus Reid group,[1] Canadian students have better access to the Internet than any others in the world except in Scandinavia. Unfortunately, as Larose, David, Lafrance and Cantin (1999) discovered, the lowest level of ICT use occurs in faculties of education, where teachers are prepared to meet the challenges of the new millennium and where in-service education and professional development are delivered to practising teachers.

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[1]   Source: www.angusreid.com/services/p_face.cfm.

[translation]

> [...] They (humanities professors) are among those who use these teaching tools the least. Finally, one factor sets the sub-sample of instructors in the faculty of education apart from the sample as a whole. Professors in this faculty have a much less favourable attitude than their colleagues (in the applied sciences) toward pedagogical use of ICT and a significantly higher level of anxiety than [...] (Larose, David, Lafrance and Cantin, 1999).

The potential benefits of technology can only be achieved, however, if university instructors are aware of its importance and specific contribution to teacher education. As pointed out by Perrenoud (1998), instructors must not relegate ICT to optional, superfluous activities, *"to be done when we have time."* Instead, they must adopt an attitude of *"cultural, sociological, pedagogical and didactic awareness to understand the future make-up of schools, their clients and programs."*

This technological revolution, which faculties of education notably appear to have missed, does create a new framework for filling their role and provides benefits that universities can and must highlight when carrying out their basic education and research mission. Thus, the first challenge faced by faculties of education is to strike the right balance between maintaining some traditional aspects that have contributed extensively to teacher education for centuries, while capitalizing on the new opportunities presented by information and communication technology. In particular, if a university's mission includes preparing teachers more effectively to face the challenges of the third millennium, through pre-service as well as in-service education, it has no choice but to promote the regular and ongoing integration of information and communication technology into higher education. New technology is supposed to add value to education, support more effective pedagogy, in part through a better relationship to knowledge for learners, and enhanced communication that promotes learning (Privateer, 1999). Grégoire, Bracewell and Laferrière (1996) also note that the opportunities for networking and collaborative learning mean that several principles or theories promoting learning can be more easily integrated into teaching. ICT also provides an opportunity to reconfigure and shift in time and space exchanges between people, and opens new avenues for pre-service and in-service teacher education activities that are more numerous, more diversified and especially more suited to the needs voiced by players in education.

As part of pre-service and in-service teacher education, can this mission of integrating new technology be achieved despite the new problems facing faculties of education, which often have run out of energy, money and resources? The answer now appears self-evident as teacher education officials and instructors can no longer ignore ICT, at the risk of being discredited. The key is to understand better how this efficient pedagogical integration of ICT can be achieved. Do instructors' practices have an impact on the practices of future teachers? Have the obstacles and factors linked to change and efficient pedagogical integration of ICT evolved in recent years? Are faculties of education meeting the professional development needs of future and practising teachers? Based on these questions, we have developed three general objectives that we hope to address in this report:

Objective 1

Better understand the motivation of future teachers for pedagogical integration of ICT into a school environment.

Objective 2

Better understand the needs of current and future teachers in terms of the knowledge and skills required for efficient pedagogical integration of ICT into a school environment.

Objective 3

Better understand the role of pre-service or in-service teacher education professionals and instructors in Canada in the process of integrating ICT into teaching. This report strives to present a (meta)analysis of existing research in the field (objectives 1, 2 and 3). It also relies on research in progress, including two complementary projects on integration of ICT funded by the *Social Sciences and Humanities Research Council of Canada* and two projects funded by the *Fonds pour la formation de chercheurs et l'aide à la recherche* (objectives 1, 2 and 3). Each objective will be discussed in a separate section of this report.

II. MOTIVATION OF FUTURE TEACHERS AND PEDAGOGICAL INTEGRATION OF ICT IN THE SCHOOL ENVIRONMENT

Many university instructors encounter difficulties promoting the development of and support for motivation of their students, especially in the area of pedagogical integration of ICT. Yet motivation heads the list of factors influencing learning at university. Although there can be many other factors affecting success, motivation currently appears to be one of the best predictors (Dweck and Elliot, 1983). Laferrière (1997) even states that learner motivation is not just important for learning but is actually a key factor.

The motivation construct

Motivation forms a central construct of theories of learning. It is a hypothetical concept representing physiological and psychological processes (Vallerand and Thill, 1993). Motivation is also the *tensor* of the internal and external forces, whether goal-oriented or not, that influence an individual cognitively, emotionally or behaviourally (Pintrich and Schunk, 1996; Karsenti, 1998). This is a process that ultimately acts the triggering, direction, intensity, persistence and la frequency of behaviours or attitudes (Karsenti, 1998). This is a complex hypothetical construct linked to that of attitude in that motivation implies intentionality and serves as the base for the interface area between subject proactiveness, inertia or withdrawal. In the field of learning, motivation is also linked to the concept of autonomy since proactiveness implies the subject's ability to conduct a contextual analysis, set a goal and determine steps and methods for achieving this goal (Atkinson and Raynor, 1974; Weiner, 1986). In cognitive psychology, motivation to succeed is a function of individual desire (expectations), feelings of personal effectiveness, and reinforcement or support found in his social surroundings (Pintrich and Schunk, 1996); it therefore is a personal characteristic of the learner.

The motivational aspects of ICT-supported learning are relatively well documented, although sometimes contradictory (Warschauer, 1996). The literature attributes the positive impact of ICT use on motivation to four factors: working with a new medium (Fox, 1988; Karsenti, 1999), the more personalized nature of teaching supported by ICT (Relan, 1992), the potential for greater learner autonomy (Williams, 1993; Viens and Amélineau, 1997; Karsenti, Savoie-Zajc and Larose, 2001) and finally, the potential for frequent, fast feedback (Wu, 1992; Karsenti, Fortin, Larose and Clément, 2002).

Motivation of future teachers and integration of ICT
A recent study on the motivation of future teachers to integrate ICT into their teaching practices showed that the presence of model instructors or participation in a course that optimized use of ICT could have a positive impact on the motivation of future teachers to integrate ICT into their teaching practices (Karsenti, Savoie-Zajc and Larose, 2001). Moreover, the preliminary findings of a survey of some 10,000 future teachers[2] reveal that commitment to and perseverance in pedagogical integration of ICT during practicums (practical education of future teachers) appear highly dependent on five factors or determinants:

- pedagogical integration of ICT by the associate teacher;
- the future teacher's degree or level of computer literacy;
- pedagogical integration of ICT by instructors during university education of future teachers;
- a future teacher's expectations of success in integrating ICT;
- the value placed on ICT by future teachers.

Thus, future teachers taking practical education (practicum) in a setting that places importance on integration of ICT are more likely in turn to have a special interest in integrating ICT into their own teaching practices. A future teacher with proficiency in ICT and wide experience integrating ICT during his university education will also be more inclined to integrate ICT into his teaching. Finally, expectations of success in integrating ICT and the value placed on ICT are also key factors in the motivation of future teachers to integrate ICT. These results also appear consistent with other studies on motivation which show that an individual's motivation is closely linked to his expectations of success and to the value placed on learning (Chouinard, Karsenti and Fournier, submitted; Pintrich and Schunk, 1996; Pintrich and Schrauben, 1992).

Future teachers who do not extensively integrate ICT into their teaching practices have few expectations of success integrating ICT, which often appears to be linked to their poor computer literacy. These individuals also fail to see how ICT could enhance teaching or learning. Instead, they perceive ICT as time-consuming, when lack of time poses a daily challenge. They find school settings that make little use of ICT more reassuring than those that make extensive use of this technology. Finally, their very limited experience with integration of ICT during their university education is perceived as a failure or waste of time.

The five characteristics likely to foster motivation of future teachers to pedagogically integration ICT into their professional practice appear to provide an interesting approach for achieving major ICT penetration into the school environment. Although these analyses are only preliminary, the large number of respondents (some 10,000) provide an indication that they may be major determinants of the motivation of future teachers to integrate ICT.

III. NEEDS OF CURRENT AND FUTURE TEACHERS FOR EFFICIENT PEDAGOGICAL INTEGRATION OF ICT IN THE SCHOOL ENVIRONMENT

Teacher education in ICT must be based on the material students must learn. For that reason, this section of the report first briefly reviews the skills that students must develop. It then examines the various needs of teachers. A final section suggests avenues for professional development.

Student's technological skills:
Canadian and American standards
The past 10 years have led most Western countries to place importance on educating students to use technology. Student education profiles are presented here because they should guide the identification of skills expected of teachers and thus, their education needs. For example, we emphasize the skill profiles presented by Canadian curricula developed by four provinces as well as the *National Education Technology Standards* developed in the United States.

Quebec's curriculum (2001) considers appropriation of ICT one of the methodological cross skills that must be developed by preschool and primary students.[3] The skills listed fall into three categories: appropriation of ICT (purposes, concepts, vocabulary, procedures and techniques specific to ICT); use of ICT to perform a task; assessment of the effective use of technology.

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[3] The curriculum for secondary education has not yet been released.

Manitoba's curriculum (Council on Learning Technologies, 2001) highlights three types of skills that students must develop: use of technology to structure requests for information (problem solving, gathering, organizing, validating and communicating information); management of ICT (creative, productive and efficient choices of technology to perform a task); understanding of ICT (ethical issues, effects of use, etc.). Post-secondary students in Manitoba must also acquire the abilities to support life-long learning.

In Nova Scotia (Nova Scotia Department of Education, 1999), learning outcomes are divided into five areas: basic operation and concepts; production tools and software; communications technology; research, decision making and problem solving; social, human and ethical issues.

Alberta's curriculum (Alberta Department of Education, 1997) distinguishes three areas of learning linked to ICT: basic operations, knowledge and concepts, processes leading to execution of work using software tools; investigation, decision making and problem solving. The American list of standards identifies six categories of skills related to basic operations and concepts; social, ethical and human issues, as well as four types of tools: software tools; communication tools, those that facilitate research, and problem-solving and decision-making tools.

In brief, most curricula distinguish a **first level of appropriation of basic concepts, vocabulary and techniques** and a **second of use of ICT to perform tasks, solve problems and make decisions** (including information processing). Most address social, human and ethical issues (including assessment of the impact of using ICT). One curriculum places emphasis on developing life-long learning skills.

Needs of future teachers and integration of ICT:
The case of university instructors
The issue of teachers' needs in pedagogical integration of ICT requires that we first examine the situation in pre-service and in-service education. Following this, various needs are identified. For almost 10 years now, studies have shown that future teachers lament the fact that technology is not integrated into the entire curriculum (Walters, 1992), that their professors have not personally integrated technology into their own teaching (Bosch and Cardinale, 1993), and when they do, they turn to the simplest and least innovative technology (Office of Technology of Assessment, 1995).

Since that time, the situation appears to have changed little, as indicated by several American studies. For example, Strudler and Wetzel (1999) submit that many future teachers function in the classroom with very little training and few models for using ICT. Brinkerhoff, Ku, Glazewski and Brush (2001) show that use of ICT by future teachers reflects a low level of technopedagogical skills. In this same study, the future teachers surveyed even find that the lack of training poses one of the greatest barriers to implementing technology in teaching and learning.

In the Bennett and Daniel (1999) study, new teachers report a lack of knowledge and abilities for managing use of computers in the classroom (students' computer work methods, managing work performed on computers). They also stress the lack of continuity between what they have learned in their pre-service education and the skills they must use in the classroom.

In Quebec, the Conseil supérieur de l'education (CSÉ, 2000) found a certain delay in training on pedagogical integration of ICT. It specifically highlights the low importance placed on ICT training in pre-service education programs (usually only three credits). It also points out that this course consists of [translation] *"[...] a summary familiarization with the tool that shows few links with its use in the context of daily teaching."* (p. 68).

In brief, many studies[4] point out, in part, that new teachers have certain "knowledge" about ICT, but have little practical knowledge and little or no *technopedagogical* skill to integrate ICT into their professional practice. As already demonstrated (Karsenti and Garnier, 2002), this finding is not specific to future teachers of Canada but is found as well among other teachers in North America[5] or Europe.[6] The international nature of the problem of integrating ICT for future teachers therefore appears to further reinforce the relevance of studying this issue. Today, future teachers today continue to receive inadequate training in pedagogical integration of ICT. They also have few role models among their university instructors.

Needs of future teachers and integration of ICT: The case of experienced teachers

Experienced teachers play an important role in educating future teachers since they should suggest approaches for using ICT in actual classroom situations and should support future teachers' experiments with learning activities that make use of ICT. The Brinkerhoff, Ku, Glazewski and Brush (2001) study shows that although experienced teachers supervising the practical education of future teachers generally believe in the importance of integrating ICT into their teaching, these teachers say they personally use it more for management, that is, purposes not linked to learning and teaching. In addition, Becker, Ravitz and Wong (1999) note that in a year, a typical teacher provides his students with fewer than 10 opportunities to work on the computer.

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[4] See Karsenti, T. and Larose, F., (2001). *Les TIC…Au cœur des pédagogies universitaires.* Quebec City: Presses de l'Université du Québec. 256 pages.

[5]   Levin, B. B. (1999). Is the Class of 1998 Ready for the 21st Century School? Longitudinal Study of Computer-Using Teacher Candidates. ERIC Publications (ED432556).

[6] Scottish Board of Education (2000). *The impact of Information and Communications Technology initiatives. Interchange 63.* Edinburgh: SEED.

Although the earlier portrait is based on empirical studies often conducted in the United States, the situation is similar in many other countries. In Canada, and especially in Quebec, the Conseil supérieur de l'education, in its report on education and new technology (2000), concludes that few practicum students have an opportunity to complete a practicum (practical education) with a teacher interested in the various computer tools, who uses them for teaching and learning.

In brief, experienced teachers continue to make less use of ICT and feel qualified to work in a fairly limited range of applications. As pointed out by Duchâteau (1996), the failure of technology in schools could be explained by the gap between promise and reality. He claims it is impossible to talk of pedagogical integration of technology without truly changing the rest of the school environment or the pedagogy used in schools. The real challenge of integrating ICT into schools lies here.

Needs of future teachers and integration of ICT: Striking the right balance

To strike the right balance for pedagogical integration of ICT in teacher education, we must achieve a better understanding of teachers' rapidly changing needs for effective pedagogical integration of ICT in the school environment. These needs are ranked by their relationship to expected knowledge, abilities and skills, or professional development.

Expected knowledge, abilities and skills
In research conducted in Scotland on primary and secondary teachers, Williams, Wilson, Richardson, Tuson and Coles (1999) found that teachers have varied needs in the area of ICT. Many place priority on learning more technical knowledge and skills. They want to know the various possible uses or applications in the classroom linked to specific content in the curriculum. They want practical examples. They also want to know the various resources available and how to critically assess those resources. These researchers recommend that teachers take training to develop advanced skills for using ICT, so they can integrate ICT into their teaching practices, if not their daily life. They also specify that teachers must be able to work with several types of computers, interfaces and technology.

Feder, Bernau, Fisher and Quintana (1999) of the Colorado State Department of Education compiled an inventory of the knowledge and skills that various professionals, including teachers, must possess to work with computers or communications technology, to meet the needs of learners. These skills and knowledge are divided into three categories[7]:

1) ***Basic operations and concepts related to computers and technology***
   Teachers are able to use a computer and various technological tools. This includes the use of software and basic operations such as booting a computer, opening software, saving, recording, creating, manipulating, publishing and distributing information.

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[7] The authors compiled an exhaustive list of the expected knowledge, abilities and skills, which they assembled.

2) Personal and work-related use of technology

    Teachers are able to use these tools in their classroom to improve their productivity and professional growth. They have acquired the basic skills that enable them to use the most advanced functions of publishing and communications software as well as audio or video equipment.

3) *Integrating technology into a basic standard curriculum*

    Teachers are very proficient in the use of a variety of software and communications tools. They now have the skills required to integrate the use of computers and technology into their teaching strategies and also to adapt their interventions to their students and the subject matter.

Eisenberg and Johnson (1996) indicate that a solid computer literacy curriculum must be more than a simple list of isolated skills, such as knowing the components of a computer, writing a draft and producing a finished text using a word processor, saving documents, etc. Although they consider these important skills, a curriculum in list form does not foster the transfer of subject matter learned from one situation to another. Learners do not see the link between the various skills. They must be able to use a computer flexibly, creatively and for a specific purpose.

Professional development of current teachers in ICT: a few approaches

This section examines a survey of work on professional development to identify the characteristics of programs that show promise. It highlights some of these characteristics that have proven quite effective. It then focuses on the aspect of professional development that should prevail, especially in relation to appropriation of ICT. Finally, this section presents a process that empowers teachers to take charge of their professional development: self-regulation of learning.

A research team has just conducted an initial broad-scale study to identify the characteristics of professional development activities that promote learning by teachers (Garet, Porter, Desimone, Birman, and Suk Yoon, 2001). Their findings reveal three characteristics with a positive effect on teachers' self-reported growth of knowledge and abilities, as well as changes in their classroom practices. This is the emphasis placed on knowledge linked to content, opportunities for active learning and consistency with other learning activities.

In the Williams, Wilson, Richardson, Tuson and Coles (1999) study, respondents indicated that the acquisition of knowledge and the development of skills linked to ICT, as well as greater pedagogical integration of ICT, required a combination of suitable training, access to ICT and ongoing support and advice to encourage progress beyond pre-service education. Each of these needs must be considered in an approach that fosters change, at a pace consistent with that of teachers and schools.

A survey of work on the desirable characteristics of professional development programs designed for teachers identifies several characteristics that such programs should include. We first note that the scientific literature, whether it deals specifically with training on pedagogical integration of ICT[8] or not, proposes similar approaches. For this reason, the two bodies of literature[9] are integrated.

The study of focuses of learning identified three areas in which teachers must build their knowledge: pedagogy (Almog and Hertz-Lazarowitch, 1999; Borko and Putnam, 1996), didactics, including students' knowledge of subjects taught (Borko and Putnam, 1996; Wilson and Berne, 1999) and the actual subjects taught (Almog and Hertz-Lazarowitch, 1999; Borko and Putnam, 1996; Wilson and Berne, 1999). To these are added the development of collaborative skills (Almog and Hertz-Lazarowitch, 1999; Voogt and Odenthal, 1999), information processing skills (Voogt and Odenthal, 1999) and, at a meta-level, awareness of their learning process (Almog and Hertz-Lazarowitch, 1999; Voogt and Odenthal, 1999; Wilson and Berne, 1999). The favoured approaches are those based on constructivism and socioconstructivism (APA, 1993; Borko and Putnam, 1996; Cooper and Hirtle, 1999; Maeers, Browne and Cooper, 1999).

Emphasis in the area of methods is placed on the importance of generating personal thought as well as peer collaboration (Abdal-Haqq, 1995; Almog and Hertz-Lazarowitch, 1999; Martin and Doudin, 2000; Wilson and Berne, 1999; Tillema, 1995). Finally, the learner's status is that of a thoughtful practitioner (Stoll, 1992), investigator (Martinello,1999), partner and collaborator (Stoll, 1992). Many studies also place emphasis on the importance of considering teachers as professionals and adult learners (Abdal-Haqq, 1995).

From the perspective of professionalization of teaching (Day, 1999), teachers must take personal responsibility for their professional development to be able to fulfil their role competently. Involvement in this approach is one of the skills to be developed as part of teacher education (Government of Quebec, 2001a). One line of research shows the potential of self-regulation of learning, which consists of a process requiring cyclical activity in three phases: planning, performance and self-examination (Zimmerman, 2000). This process is designed to optimize learning by enabling learners to improve their control over this aspect (Zimmerman, Bonner and Kovack, 1996). Just as Kremer-Hayon and Tillema (1999) point out, self-regulation of learning can contribute significantly to the education of future teachers, especially in a setting in which professional knowledge is rapidly changing.

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[8] This specific literature on integration of ICT is by Almog and Hertz-Lazarowitch (1999), Martinello (1999), Cooper and Hirtle (1999), Maeers, Browne and Cooper (1999), and Voogt and Odenthal (1999).

[9] A more complete survey can be found in: Deaudelin, C., Brodeur, M. and Dussault, M.. (2001). "Une stratégie de développement professionnel visant l'intégration des Technologies de l'information et de la communication à la pédagogie universitaire," in Karsenti, T. and Larose, F. (2001). *Les TIC… au cœur des pédagogies universitaires*. Quebec City: Presses de l'Université du Québec.

IV. PRE-SERVICE OR IN-SERVICE TEACHER EDUCATION PROFESSIONALS IN CANADA AND THEIR ROLE IN THE PROCESS OF INTEGRATING ICT INTO TEACHING

Background

Two separate aspects, occasionally confused and usually overlooked, characterize the dynamics of integrating information and communications technology (ICT) into education. These two aspects are neither special nor specific to Canada, but are present in all industrialized countries where integration of this technology is a major pedagogical and socio-political issue (Larose, Lenoir and Karsenti, 2002). These are the didactic and pedagogical aspects that may characterize the integration of computers into the world of professional teacher education, as well as the socio-political aspect that justifies the desire to integrate mastery of this technology as a focus of the curriculum.

In Quebec, since the last reform of in-service professional teacher education curriculum in 1994-1995, training on pedagogical use of ICT must form an integrated component of the various education programs in preschool, primary and secondary teaching. Since earning an undergraduate degree in one of these bachelor programs leads directly to a provincial teacher's licence, minimal construction of techno-instrumental skills within these courses therefore represents a minimum requirement for entering the profession (Government of Quebec, 2001*a*). The reformed curriculum in preschool and primary teaching as well as the general thrusts of the current master program that are guiding reform of the secondary curriculum integrate the construction of skills related to use of computers and telematics for the methodological cross skills that any student should have upon completing his education (Government of Quebec, 2001*b*).

Also in Quebec, since 1996 the Ministry of Education has made considerable efforts to network all schools in the province, and in most cases in primary school at least, students can access at least one work station in the classroom (Government of Quebec, 1996). Beyond the fact that the target of networking all Quebec schools in 2000 was met, the province considered more than just pedagogical factors. Familiarizing as many future citizens as possible with computers and especially networking, and the need for a majority of these individuals to have minimal computer literacy skills when entering the labour market, are goals consistent with the mission incumbent on schools to narrow the social disparities generated by cultural differences and differing family incomes (Larose, Lenoir and Karsenti, 2002).

Similar considerations have led various education departments in other Canadian provinces to ensure upgrading and expansion of the computer stock in schools and to ensure that schools are networked for the new millennium (Council of Ministers of Education, Canada, 2000). Yet while the computerization and networking of schools presumes a willingness among those who manage and direct provincial academic curricula to integrate use of these didactic tools directly into teaching practices, outside Quebec, this willingness does not appear to translate into qualification requirements for pedagogical use of ICT pre-service teacher education programs. Although responsibility for recognizing a skill to be taught may vary from one province to another, depending on whether there is a professional teachers' college, a quick exploration of teacher education programs available at major Canadian universities[10] reveals the presence of certain shared characteristics.

- Familiarization with various forms of pedagogical use of ICT is presented as elective courses to round out the general education profile of future teachers .

- Most pre-service teacher education programs offer a specialization in teaching ICT, within or independent of specialist training in the science and technology curriculum.

- Where the specialization is specifically the teaching of ICT or computer technology, future teachers will enter this field only at what corresponds to the masters level in Quebec.

The situation

Teaching practices

Several provincial sources find that while minimal infrastructure is present in all or the vast majority of schools in Canada, for teachers to capitalize fully on these didactic tools, this integration occurs very little at the practical level (Council of Ministers of Education, Canada, 2000; Government of Quebec, 2000; Haughey, 2000; Jefferson and Edwards, 2000; Oberg and Gibson, 1999). This phenomenon is not unique to Quebec or Canada, but occurs at the international level, regardless of the scope of financial investment by governments to provide infrastructure (upgrading and expansion of school computer stocks, networking of work stations for teachers), or of the curriculum requirements for pre-service or in-service teacher education.

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[10] Programs were analysed using descriptors available on the Internet in faculties or departments of departments of education in the following provinces: New-Brunswick (N = 1), Nova Scotia (N=2), Ontario (N = 4), Saskatchewan (N = 1), Manitoba (N = 1), Alberta (N = 2), British Columbia (N = 1).

Thus, while Great Britain invested approximately one billion pounds sterling over five years to computerize and network the entire school system, the impact on practices making pedagogical use of ICT, whether in exchanges between teachers or integrating this technology into teaching practices, was minor (Lawson and Comber, 2000; Selwin, 2000). Similarly, massive investment by Alberta's Department of Education in hardware and connecting the province's schools had little significant effect on teachers' professional relationship with network technology (Oberg and Gibson, 1999). The same has been a recurring fact in Quebec (Government of Quebec, 1994, 2000).

Some recent research suggests that teachers' pedagogical relationship with ICT is a contextualized reflection of the relationship developed with didactic material in general (Lawson and Comber, 2000). Given this, the issue if teachers' relationship to knowledge as well as their preferred models for pedagogical intervention. Thus, practices of pedagogical use or "didactic" integration of ICT essentially appear to be dependent on the representation that teachers maintain with the relative rank of school subjects and with their own skill, definitely in techno-instrumental terms, but especially on the relationship with each school subject taught (Larose, Lenoir, Karsenti and Grenon, forthcoming; Lenoir, Larose, Grenon and Hasni, 2000).

We therefore can only state that teachers, in Canada at least, do not use school computers. They specifically tend to under-utilize networking technology, and limit their integration to searching for information on known sites when preparing their courses and to encouraging their students to search for information on sites the teacher has selected in advance. This relationship appears to be repeated among new teachers and students. This apparently is attributable to the representations and practices of the experienced teachers they encounter in their practical education (practicum) or their entry into the profession (Larose, Grenon, Ratté and Pearson, 2000; Larose and Lenoir, 1998; Larose, Lenoir and Grenon, 2000; Larose and Ratté, 2001).

Teacher education practices
Study of the literature on integration of ICT as part of professional training as well as its impact on the probability of transferring skills built for professional practice reveals mixed results. Many authors who have examined the integration of this technology, especially in pre-service teacher education, find that there is little impact on their profile of use as part of practical education, or during entry into the profession (Larose, Lafrance, Grenon, Roy and Lenoir, 1999; Larose, Lenoir, Karsenti and Grenon, forthcoming; Levin, Stuve and Jacobson, 1999). Starting in the late 1990s, however, some studies noted that the concomitant use of computers as a didactic tool in courses taken at university and the use of this medium as part of "practical education" constitute conditions for genuinely optimizing learning acquired in pre-service teacher education programs (Hacker and Sova, 1998).

The use of network technology resources as part of a practicum, especially where these resources can be applied in a practice setting, so future teachers obtain support in planning and carrying out an intervention to take charge of teaching periods, optimizes the probability of integrating learning by the novice teacher. This type of use of network resources, especially when done regularly, significantly increases the likelihood of future teachers using ICT regularly in their future practice (Galanouli and McNair, 2001). The incentive for future teachers to use network technology in both synchronous and asynchronous modes, to share their experience, knowledge and concerns, in a practicum and when conducting work specific to various courses they must take at university, also appears to have a significant effect on the likelihood of using this technology when they enter the profession (Blanton, Simmons and Warner, 2001; Hedrick, McGee and Mittag, 2000; Karsenti, Fortin and Clément, 2002; Ritchie and Peters, 2001).

V. CONCLUSION

This research report, a (meta) analysis of existing research in the field, is also supported by research in progress. It reveals a need to pay special attention to pedagogical integration of ICT into the education of future teachers because this integration currently does not appear to be widespread. As the scientific literature points out, future teachers continue to receive inadequate training on pedagogical integration of ICT. Furthermore, ICT is too often marginalized in pre-service teacher education—resulting in an absence of model instructors—and this could have a negative impact on the students these future teachers will teach, especially on the widening digital gap between the various social classes.

Some authors, such as Guédon,[11] also fear that pedagogical integration of ICT may take several decades to take root, to the great detriment of students .

> [translation]
>
> Buying computers is one thing, but integrating new technology into the life of our schools is quite another [...]. When we consider how long it took educational institutions to finally adopt Gutenberg 's printing press (at least three centuries after it was invented), we shudder to think of what might happen, especially if we delude ourselves that we have solved the problem by amassing the hardware.

As part of this report, we have explored how the future teachers' motivation and perceptions of the presence of ICT in their professional practice also appears to play a key role in pedagogical integration of ICT in schools. We therefore have set out five factors likely to influence the interest of future teachers to integrate ICT: integration of ICT by the associate teacher encountered during the practicum; their degree of computer literacy; their experience integrating ICT during education at university (presence of model instructors);

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[11] Dilemmes et défis d'un nouvel âge pédagogique http://radio-canada.ca/education/index2.asp?FROM=CONV&DocID=403

their expectations of success in integrating ICT as well as the value they place on ICT. As we have pointed out, these five factors could provide interesting avenues for exploration to maximize the presence of ICT in schools. We also note that the incentive for future teachers to use synchronous and asynchronous means of communication to share their knowledge, experience and concerns, in a practicum or when conducting specific work, appears to have a notable impact on their likelihood of using ICT in their professional practice.

The literature on the needs of future teachers appears to show that two sets of skills are necessary for successful pedagogical integration: a measure of technological or techno-instrumental skill, but also technopedagogical skill. We repeat here the findings of the Williams *et al.* (1999) study in which respondents stressed that to develop skills related to ICT, and acquire a skill for technopedagogical integration of ICT, it is important to have appropriate training as well as access to ICT, and the option of obtaining ongoing, regular advice to encourage progress beyond the pre-service education. The few professional development approaches we emphasized in section III of this report take on their full significance.

Thus, although we must proceed with integration of ICT and adapt at the same time to all the inherent challenges of this integration, there is also a need to strike the right balance between successful integration of ICT into teacher education and respect for the basic mission of education and research taken on by universities and especially faculties of education. For this reason, from a pedagogical perspective, the presence of ICT in teacher education can only be justified if it contributes added value to the pre-service education of future teachers. The effort to integrate ICT will be worthwhile only if it enhances pedagogy by enabling learners to forge a better relationship with knowledge (Karsenti, Savoie-Zajc and Larose, 2001).

Sandholts, Ringstaff and Dwyer (1997) believe that ICT drive change in teaching methods and might even claim to facilitate the transition from traditional methods to a more eclectic set of learning activities that make room for knowledge construction situations. ICT also provides an opportunity to rethink and shift, in time and space, exchanges between people, thereby opening new avenues for pre-service and in-service teacher education activities (Karsenti, 1999).

If experienced teachers continue to say they make little use of ICT and feel qualified in only a limited range of applications, it then becomes crucial that future teachers be able to serve as catalysts for desired change in education. Just as Gutenberg's invention of the printing press set off a maelström of change in the world of education and in the relationship with knowledge, faculties of education today can now use new technology to "seize the day" and narrow the widening digital gap between schools and the rest of society. Faculties of education are not condemned to serve as enclaves for integration of ICT: they could take on the role of technopedagogical protagonists.

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