The impact of attitudes and technological abilities on future teachers' use of information and communication technology (ICT) with school children

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One day, people will learn through electronic circuits.
Marshall McLuhan, 1965

ABSTRACT

The purpose of this study was to understand the role of attitudes and technological abilities on the use of ICTs by student teachers during their field practice. Moreover, we wanted to uncover the factors playing a significant role in bringing prospective teachers to have their students regularly use computers in their academic classes. In all, 6998 student teachers participated in one of the largest studies in North America centered on various aspects of the use of ICTs in teacher education programs. Statistical analyses were conducted to assess the impact of attitudes and technological abilities on the use of ICTs. They reveal that both attitudes and technological abilities are positively related to the use of ICTs. These results, issued from a large-scale study, could have important implications for teacher trainers, school principals, and policy makers.

KEYWORDS: Attitudes, ICT, Teacher Education, Teacher Training, Motivation, Self-efficacy.

Introduction: ICTs and education, or a century of promises

Marshall McLuhan was thought to show great foresight when, in the 1960's, he claimed that technologies would play a crucial role in education. But more than 50 years before McLuhan, another visionary, Thomas Edison, already predicted a great future for technologies in schools. In fact, a few years after having made an educational film in 1911, Thomas Edison proclaimed: "Books will soon be obsolete in schools […] It is possible to teach every branch of human knowledge with the motion picture"[1] (1913). Since Edison's promise to revolutionize teaching through films, the integration of technologies in education has encountered many transformations and developments: the use of television, video, computer, as well as information and communication technologies (ICTs).

[1] Excerpt from a speech by Thomas Edison en 1913. Source : National Digital Library, http://memory.loc.gov (last consulted in June 2004).

Thus, for a little less than a century now, technologies have been promised a major part in education. However, since the early 1980's when, for the only time in its history, *Time Magazine* altered its annual practice of naming a "Person of the Year," choosing instead to name a "Machine of the Year", the computer and the Internet have known an ever increasing popularity within schools. In introducing the theme, *Time Magazine* publisher John A. Meyers wrote, "Several human candidates might have represented 1982, but none symbolized the past year more richly, or will be viewed by history as more significant, than a machine: the computer."
In Canada, it is at the end of the 1970's that teachers began introducing students to computers, but also to the use of certain types of software such as LOGO. Canada also became one of the first countries in which all schools have Internet access. The information society, promised in the 1970's, praised in the 1980's and looked upon in the 1990's with a combination of respect, fear and a sense of disbelief has become an obvious reality for most Canadians in the 21st century (Government of Canada, 2000).

Problem: The need for scientific, empirical studies on ICTs and teacher education programs in Quebec (Canada)

Schools and universities responsible for teacher education programs are evolving within a context of change in terms of the relationship to knowledge and are entering full force into the maelstrom of numerical information, computers and the Internet. For many, this technological revolution brings with it countless advantages that schools and universities can and must value while accomplishing their fundamental mission of education. Today, ICTs, capable of enabling universal access to knowledge, hold a power and reach for schools that not even Edison could have imagined. ICTs can simultaneously combine text, image, sound, interactivity and programming. They can also "record" and transmit worldwide. Indeed, the integration and judicious use of ICTs could allow the field of education as a whole to grow by enabling collaboration, improving research environments and contributing to intellectual production conditions in a significant manner.

While Edison's predictions took considerable time to enter the realm of reality, we would like to believe that, in 2004, we are close to their complete fulfillment. We might also hope that newly trained teachers have the necessary competencies to make regular, pedagogical use of technologies. But is this truly the case?

More evidence is indeed mounting to support the claims of technology advocates that ICTs (communication tools, computer-assisted instructional applications, etc.) can positively influence student learning. However, beyond the discourse asserting the "intrinsic virtues" of ICTs in terms of learning, the coming together of technologies and education is emerging as an independent field of research, requiring specific scientific study, probing and analysis. There are a variety of contexts in which technologies are integrated that have not – yet – scientifically and systematically proven themselves to be effective. In fact, experiences are varied and numerous but not all are valuable for learning, nor efficient for teaching.

Despite the overwhelming presence of technologies in teacher education programs and the constant increase of pilot projects focusing on teaching with ICTs, there are still many unanswered questions on their true effectiveness (see for example Ruano-Borbalan, 2001; and Zhao and Frank, 2003) and a lack of well-documented and rigorous experiments. For instance, Ungerleider (2002, p. 19) argues that "There are simply too few studies of sufficiently rigorous design to permit

informed policy choices. This is especially troubling given that the use of ICTs requires significant expenditure of scarce resources".

Hence, the arrival of new technologies in many schools and classrooms currently appears to be one of the great focuses of teacher training programs and education reforms in Europe and North America. Across Canada, a new approach can be noted in initial teacher training, stemming away from technological training and heading towards training centered on the pedagogical integration of technologies. Yet there is a certain danger in this – perhaps too hasty – swing of the pendulum.

Though it appears understandable that the ultimate objective for teacher education should be the *pedagogical integration of technologies*, it is not, however, obvious that teachers do indeed already possess the technological abilities for such an assimilation of ICTs within teaching or learning. In Quebec (Canada)[2], this uncertainty with regard to the new conception of teacher training has generated much questioning from academics in terms of the competency of future teachers to integrate ICTs, as well criticisms from school principals who feel that new teachers are not adequately prepared to integrate ICTs.

Theoretical framework

While it appears that ICTs can, in principle, be integrated into teaching practices to nurture learning and increase student achievement, various constraints have often muffled teachers' use of ICTs. Indeed, Osborne and Henessy (2003) highlight that even where technology is available, it is often underused and hindered by a set of practical constraints and teacher reservations. Various studies conducted both in Europe and North America have also shown that regardless of teacher training programs and an increase in ICT resources, there has been a disappointingly slow uptake of ICTs in schools by the majority of teachers (Cuban, 2001).

Various explanations could be given for this lack of sustained increase in the pedagogical use of ICTs in the classroom, such as the lack of time (Fabry and Higgs, 1997; Preston, Cox and Cox, 2000; Cuban, Kirkpatrick and Peck, 2001), the lack of self-confidence in using ICTs (Pelgrum, 2001; Yan and Piper, 2003), negative experiences with ICTs in the past (Snoeyink and Ertmer, 2001), classroom management difficulties (Drenoyianni and Selwood, 1998), and, particularly, the insufficient motivation of teachers (Cox, Preston and Cox, 1999a; Cox, Preston and Cox, 1999b; Braak, 2000; Carter and Leeh, 2001; Kankaanranta, 2001; Snoeyink and Ertmer, 2001; Hammond, 2002).

Indeed, motivation, a force that energizes and directs behavior toward a goal (Eggen and Kauchak, 1994), is critical for learning, and several researchers have found a positive and robust correlation between motivation and teachers' use of ICTs in Europe (Braak, 2000) and North America (Lin, Hsieh and Pierson, 2004). In their investigation, Yan and Piper (2003) examined, among other things, the relationship between self-efficacy, attitudes, and teachers' implementation of computers in the classroom. They found a strong relationship between motivation and computer use in the classroom.

Are computers playing a significant role in teachers' instructional practices? Larry Cuban

[2] Though we sometimes refer indifferently to Quebec or Canada, it is important to note that education in Canada is the responsibility of each province (there are ten provinces, and Quebec is one of them). Nevertheless, there are many similarities among the educational systems of each province, including teacher education programs.

continues to argue that they are not (Cuban, 2000; Cuban, 2001). Using data from a national survey of 4,100 teachers' pedagogy, computer use, and teaching environment, Becker and Ravitz (2001) show that Cuban's postulate is true, in a statistical sense. Is it still the case in 2004 ? What is the impact of attitudes and technological abilities on teachers' use of information and communication technology with school children ? These are some of the questions that led to our undertaking of one of the largest studies on ICTs and teacher training ever carried out in North America or Europe[3].

Objective

The goal of this study was to understand the role of attitudes and technological abilities (mastery of technical aspects of ICTs) on the use of ICTs by student teachers during their field practice[4]. We also wanted to find out which other factors played a significant role on the use of ICTs by prospective teachers working with school children. Moreover, we were looking to uncover some of the factors playing a significant role in bringing prospective teachers to have their students use computers regularly at school, in their academic classes.

Method

Subjects
In all, 6998 student teachers participated in one of the largest studies in North America centered on various aspects of the use of ICTs by prospective teachers. The subjects represented 70 % of all student teachers enrolled in a four-year teacher education program from all Quebec (Canada) universities offering initial teacher training in 2003. They had a mean age of 21.3 years old, and 85% were women, 15% men, percentages that correspond to the usual breakdown of the population enrolled in teacher training in Quebec (Canada). A total of 1959 student teachers were in their first year of study, 1540 were in their second year, 1889 in their third year, and 1610 in their fourth year.

Procedure and Measures
The study consisted of a questionnaire administered to prospective teachers from all francophone, Quebec (Canada) universities (n = 9) offering initial teacher-training programs in 2003. In order to reach as many student teachers as possible, the questionnaire was administered during compulsory courses, with the necessary authorizations. The questionnaire was composed of several validated scales measuring prospective teachers' attitude towards technology, as well as their technological abilities with ICTs. The scales were identified by a review of the literature on ICTs and student teaching. The attitude-motivation scale is based on Deci and Ryan's motivation theory (2000) and was validated in previous studies (see Karsenti, Savoie-Zajc and Larose, 2001**)**. The internal consistency of the subscales was assessed with the use of the Cronbach alpha. Results from this study reveal that the internal consistency of all subscales is excellent, ranging from .78 to .91. The self-efficacy scale was based on Bandura's self-efficacy theory (1989). We used the Dussault, Villeneuve and Deaudelin scale (2001). Data obtained in this investigation also reveal strong Cronbach alphas for all subscales, ranging from .72 to .84.

[3] This study was conducted with a grant from the Social and Human Sciences Research Council of Canada.
[4] In Quebec (Canada), every teacher education program lasts fours years and student teachers are required to complete 120 days of supervised practicum (field practice) in schools associated with universities.

The final procedural step of our investigation consisted of statistical analyses to assess the impact of attitudes and technological abilities on the use of ICTs by student teachers. We wanted to ascertain the underlying factors (in particular attitudes toward ICTs and technological abilities) related to student teachers' use of ICTs with school children, during their field practice. The SPSS 11.0.1 (on Mac OSX) correlation program was used to create an intercorrelation matrix for the data. Both a factor analysis and a logistic regression were then conducted in order to determine which of the factors are useful for predicting student teachers who will use ICTs, and those who will not.

Results

As previously mentioned, the results of statistical analyses conducted first inform us on those who completed the questionnaire: 85% females and 15% males. However, the proportion of women is much higher in initial teacher training for preschool and elementary (94%). The data collected also sheds an interesting light on the attitudes and competencies related to ICTs for newly trained teachers. Also, it is interesting to point out that as those questioned were undertaking their field practice, the results of this study also afford us a privileged outlook on the use of technologies in close to 7000 Canadian classrooms.

Future teachers and the mastery of ICTs

We asked various questions on technologies for a better comprehension of future teachers' access to these tools, but also to understand their level of competency with regard to the use of ICTs. The results of our study show that 95% of respondents have access to a computer at home and 85% also have an Internet connection at home. A total of 6368 (91%) claim to be "good" to "expert" in terms of the use of word processing, a tool which they use mostly for planning and teaching management. In terms of presentation software (PowerPoint), more than 55% feel they are "novices" and less than 1% see themselves as experts. With regard to the creation of Web pages, a total of 6018 (86%) consider themselves to be novices while less than one respondent out of 700 (0,9 %) claims to be an expert. In short, we observe that future teachers in Canada generally have great access to ICTs. However, in terms of their mastery of tools (software) that can be used in the classroom (presentation or Web page creation software, for example), future teachers do not consider themselves to be able users. This result may appear surprising, especially when we know that presentation software such as Power Point has existed for close to 20 years. As for Web page creation, an ability which many claim is at the heart of today's classroom pedagogical innovations, it is startling to note that such a great number of teachers still claim to be beginners, in a country like Canada, ranked among the first countries in the world for Internet connectivity.

Attitude of future teachers towards ICTs

A great number of studies have shown that human factors such as motivation and the feeling of competency are likely to support or inhibit behaviors (see for example Deci and Ryan, 2000), such as the use of technologies in the classroom (Ungerleider, 2002). We were therefore not surprised by the results of our study showing that a high level of motivation (according to Deci and Ryan's self-determination theory) and a strong self-efficacy belief (or feeling of competence) with regard to ICTs go hand in hand with a greater use of ICTs in the classroom. The same goes for the pedagogical value granted to ICTs: the more prospective teachers find that it is important for their students to learn with the help of ICTs, the greater the place devoted to technologies in the classroom. The results of our study do, however, have the particularity of relying mostly on human factors (motivation, feelings of competence and the pedagogical value given to ICTs) to explain the use, or non-use of ICTs by future teachers during their field practice. It thus appears that technological abilities and equipment – which are essential conditions for the integration of ICTs –

are important but not sufficient. Integrating ICTs in the classroom also appears to be a question of motivation and attitude.

Practical training (field practice) and ICTs
In one of the sections of the questionnaire, we were trying to understand if future teachers use ICTs in a teaching context during their field practice. In this matter, we believe we obtained the most interesting results of our study. For the question *"During your last field practice, did you use ICTs?"*, 46% of student teachers answered "never" or "very rarely". However, for the whole of the respondents registered in the preschool and elementary teacher training program, the use of ICTs is more frequent (only 35% indicate that they never or very rarely use ICTs).

With regard to the question *"In what context did you use ICTs during your last field practice?"*, those future teachers who had used ICTs answered:

- To find information and surf on the Web - often to prepare lessons or activities - (42%);
- For projects, assignments and activities undertaken with the students (23%);
- For pedagogical support - for instance, the creation of PowerPoint presentations - (15%);
- For management, planning and organization of teaching - for instance, to tabulate marks using a spreadsheet - (13 %);
- For communication using email, forums or even chat rooms (8%);
- For the initiation of students to computer technologies (7%).

This question helped us understand the various utilities of ICTs for student teachers during their field practice. However, it also demonstrated that most student teachers use ICTs to prepare, plan or teach, but that they seldom get their students to use ICTs. In fact, as for the people registered in the secondary teacher training program, aside from the technology course or the use of ICTs for lesson planning, it is close to 95% of prospective teachers who indicate that they "never" or "very rarely" use ICTs in the classroom.

The difference in the use of ICTs made by teachers at the elementary or secondary level is thus major and should lead us to reflect on the organizational mode of secondary school. It is also interesting to note that regardless of the study program of student teachers (elementary, secondary, etc.), it is always women who make greater use of ICTs than men.

Discussion

Surveys and investigations always involve a certain margin of error and we must often be cautious in our analysis and interpretation of the data collected. Nonetheless, a total of 70% of the future teachers (6998) trained in Quebec (Canada) participated in our investigation.

Indeed, we could have presented all the innovative and exemplary uses of ICTs observed (and they are often impressive), but the objective of our study was to understand the role of attitudes and technological abilities on the use of ICTs by student teachers during their field practice. We also wanted to find out which other factors played a significant role on the use of ICTs by prospective teachers working with school children. Moreover, we wanted to uncover some of the factors playing a significant role in bringing prospective teachers to have their students use computers regularly at school, in their academic classes.

This would help us understand if, in general, future teachers in Quebec (Canada) are adequately trained to integrate ICTs. That is why our analysis was mainly centered upon the respondents as a whole, and not on the exemplary use of ICTs by certain student teachers. Finally, it is important to highlight that our results are specific to the Quebec (Canada) context, different from others, but also similar to many.

Should secondary school be transformed?

While the Quebec (Canada) Government is debating the future and organization of junior colleges, the results of our study lead us to question the organization of secondary schools in Canada. How is it that the use of ICTs for pedagogical purposes in high schools is so sporadic, particularly when we note the increasing use of ICTs in other areas of society? Is the integration of ICTs incompatible with a system that requires teachers to change classrooms regularly (that is what takes place in Canada)? Is the fact of bringing the students to a computer laboratory, often reserved for computer science courses, a highly precarious activity? Indeed, some high schools in Quebec (Canada) do innovate with laboratories dedicated to the pedagogical integration of ICTs for other subject areas, but these are isolated initiatives that do not necessarily reflect the general tendency within the network of secondary schools. Moreover, the conclusions of a recent study by the Organisation for Economic Co-operation and Development (2004), *Completing the foundation for lifelong learning: An OECD survey of Upper Secondary Schools*, show how the organization of teaching hours, of the classroom… and the weak technopedagogical competency of the teachers do not allow for the true integration of ICTs in the secondary school (high school) classrooms of some 15 industrialized countries. The report first highlights that the use of ICTs is "disappointing" in secondary school establishments in these countries, and this, even if significant spending on equipment in the past 20 years has allowed the incursion of ICTs in almost all of these schools. The conclusions of the report reflect this disillusionment toward the power of technology for education. In fact, the use of technologies for pedagogical purposes in secondary schools as a whole within these countries is sporadic and almost non-existent: "The results here remain disappointing. Only a minority of teachers across countries regularly uses standard computer applications, according to their principals […]. E-mail is hardly used by teachers in schools […]" (OECD, 2004, p. 133-134).

Many will thus say that there is no need to worry as this report concords with the results that we obtained, and this even if neither Canada nor Quebec participated in the study by the OECD. For both Canadians and the other participants stemming from 15 different industrialized countries, it is far from reassuring to note that we are similar to one another, that is, ***off track***, with regard to teacher training and ICTs. Would it not instead be the perfect occasion for our various educational systems to stand out and innovate in terms of the pedagogical integration of ICTs in teacher education programs and, eventually, in secondary schools?

Winning conditions seem in place at the elementary-school level

At the elementary level, the results of our study show that most future teachers have the possibility of bringing their students to a room in which there are several computers. Moreover, almost 30% of the classrooms are equipped with computers (numbers vary between 1 and 7). This combination of means – a computer laboratory and a few in-class computers – leads to various possibilities for the pedagogical integration of ICTs by future teachers at the elementary level. Thus, there is potential. Now, it must be ensured that the training of these teachers allows them to take full advantage of the possibilities.

Four years to learn to create a Web page?

The results of our investigation highlight that future teachers in Canada generally have a good mastery of word processing after four years of university training. Yet, with regard to presentation software, we note that less than 1% of the respondents consider themselves to be experts. As for the creation of Web pages, it is an ability that is not yet mastered at all by the vast majority of respondents. Many will suggest that this result is not surprising or even "customary" and that prospective teachers have no need to master complex technological tools to integrate ICTs in their classrooms. Is this affirmation quite levelheaded when many researchers and practitioners are working on the development of complex learning tools? Can it still be said, in 2004, that the creation of Web pages is a complex and advanced technological process? With some 550 billion documents on Internet and more than 7.5 million new Web pages created every day (Varian and Lyman, 2002), it is difficult to conceive of Web page creation as an advanced technical ability. In certain workshops, and with various software, it has been shown that a Web page can be created in a matter of a few minutes. How is it, then, that after four years of training at the university level, so few student teachers feel able to create a Web page or even upload a document on Internet?

It is said that the Internet network will shortly overflow as there is only room for 4.7 billion different addresses (in light of this, a new system will be implemented, the IPv6, which will accept 340 billions of billions of billions of billions addresses). Why couldn't newly trained teachers participate in the dissemination of information on Internet? Is this not one of the functions of ICTs in education? ICTs are not only means of communication and consultation of documentary sources, but also means of production. How can we envision production with the help of ICTs if newly trained teachers are unable to create Web pages (and therefore help their students do so), a competency which is seen more and more as one that is fundamental?

Conclusion: Must we alter initial teacher training to meet the challenge of integrating ICTs in the classroom ?

Although some of our research results can be interpreted in various ways, one element seems difficult to explain: how is it that almost half of the future teachers claim not to have used ICTs during their field practice, while all schools in Quebec (Canada) have been equipped with computer laboratories and connected to Internet since 1999[5]? Is this not a strange result for a society that stands as one of the most technologically advanced on the planet[6]? How can we presume that technopedagogical competency will be acquired by newly trained teachers if, on the one hand, universities decrease ICT training and, on the other hand, more than 50% of prospective teachers do not have the opportunity to use ICTs during their field practice? Before the situation worsens, it thus appears urgent to ensure that future teachers receive adequate training in the integration of ICTs that allows them to develop the competencies targeted in education. And beyond the amalgamation of training modes, our goal should be that of integrative alternation that would enable the coming together, simultaneously rather than in separate training processes, of the development for knowledge and know-how within the real context of action.

One of the last surveys of Statistic Canada[7] shows that more than 99% of adolescents between 12 and 17 years of age have used the Internet. In a world where children – those from elementary and secondary schools – coexist with technologies on a daily basis and where Internet is becoming for most the first source of access to knowledge, the training of future teachers for the pedagogical use

[5] Source : *Ministry of Education*: [http://www.meq.gouv.qc.ca/CPRESS/cprss99/c990614.htm]
[6] Source : Ipsos-Reid ICT survey : [http://www.ipsos-reid.com]
[7] Source : [http://www.statcan.ca]

of ICTs would appear paramount. Furthermore, while for years many academics in North America were against overly technological training at the university level, we realize today, particularly in light of our research results, that it still has its place and purpose.

This study should contribute to our rising above the simplistic discourse on the integration of ICTs in teacher education. In order that all students may, in the long run, benefit from better instruction, universities that train teachers must call upon a wide range of possibilities offered to them by new technologies as well as open and distance learning to enhance ICT training in teacher education programs. However, if we want to progress beyond the exploratory phase of training teachers to use ICTs efficiently in their classrooms, we must center and structure efforts on scientific research results and well-documented pilot projects.

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