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Preparing Teachers and Schools for the 21st Century in the Integration of Information and Communication Technologies. Review of Recent Report in the U.S. [1]

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Summary

The year 1996, marked the initiation of the project *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge* (U.S. Department of Education) which was based on four pillars: providing schools with adequate hardware, access to the internet, software, and training for teachers. The grant program aimed to integrate technology in the field of education in the 21st century. From this moment on, many have elaborated reports in an attempt to measure the success of this plan as well as the comment on the state of Schools, teachers, and Schools of Education insofar as their use and implementation of technology.
This article endeavours to create a synthesis of the predominant opinions presented by academics in the second half of the 1990's and the first years of the new millennium, about the introduction of technology into the classroom as proposed by this plan, and will, in some cases, call for their revisions. At the same time, the writing assesses, from a perspective enriched by time, exactly how much of what was suggested by the educational experts was actually put into effect.

Keywords: Training teachers, Reports, US, Integration of ICT

Introduction

In 1997 the report elaborated by the National Council for the Accreditation of Teacher Education (NCATE) affirmed that there is not one single question to be asked with respect to the way in which new technologies will be used in schools, although all seem to be in agreement that students should have access to computers, media and other technologies in the classroom. Some believe that these technologies are necessary because they develop capacities for a professional future. Others see the potential that they could have for social participation. Finally, and perhaps most importantly, the research corroborates that using technology can actually

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improve a student's learning process. What is less certain is when and how the new technologies will be able to change the very life of the schools.

One year before in 1996, the Clinton Administration fought hard for technology in schools and set a lofty goal: to integrate technology in all public schools by the year 2000. This project was called Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge (U.S. Department of Education, 1996). This project was carried out from 1996 to 2000 at a total cost of two billion dollars. It was based on the following four pillars or objectives: availability and access to the necessary hardware for instructive use; appropriate educational content (software and other applications); internet connections in all schools; adequate training and professional development for teachers.

Coinciding with Clinton's proposal, the CEO Forum on Education and Technology emerged in the fall of 1996 in order to aid in the preparation American schools so that all students may become productive citizens and workers in the 21st century (cfr. www.ceoforum.org). From this project, diverse publications came forth centred on the four pillars of the project initiated by Clinton: hardware, content, internet access, and professional training for teachers (CEO, 1997, 1999, 2000a, 2000b, 2001). The appendix presents some specifics about the impact of the enormous investment of the Getting America's Students Ready for the 21st Century project evaluated by the CEO Forum. These reports are followed by others that evaluate the use of technology in schools as well as the information offered by the Schools of Education (cfr. OTA, 1995; NCTAF, 1996; NCATE, 1997; ACE, 1999;WBC, 2000; NCES, 2000, 2005; NCREL, 2001; U. S. Department of Education, 2001).

This article is based on these reports and other documents produced in the second half of the 1990's and the first years of 2000 that study, analyse, and evaluate the use of technology in schools, as well as training of in-service and pre-service teachers. There were two effects of this reports. First they gave way to the creation of the program Preparing Tomorrow's Teachers to Use Technology in 1999, financed by the U.S. Department of Education. The principal goals of this program concerned the preparation of future teachers (current student teachers) through the comprehensive training of their faculty in the Schools of Education, the reform of Program. Second the amplification of technology standards on the part of International Society for Technology in Education (ISTE). The objective of this article is to synthesise and assess what changes needed to be made to previous proposals so as to successfully introduce technologies in teaching, as well as to present an evaluation of results with an enlarged perspective gained over time.

The first section presents the major conclusions regarding to the educational potency that the new technologies offer to schools. The second section presents the steps that must be followed to integrate technologies in the future. The assessment of technology training for teachers and future teachers in education schools, as well as the need to reform these programs are proposed in the third section. Lastly, conclusions are drawn that attempt to estimate to extent to which the recommendations for the implementation of technology in these schools have been carried out, and new recommendations are devised.

1. THE POWER OF TECHNOLOGY IN LEARNING

The efficacy of technology in teaching

In the pioneering report by Office of Technology Assessment some of the potential benefits that use of technologies in the teaching field could already be seen (OTA,1995). Even today, the results that OTA anticipated remain valid. Some of the most striking forecasts that document makes are that the technologies integrated through formal and informal courses, online training, "just-in-time", would facilitate and strengthen professional development. Furthermore, technologies improve the quality and effectiveness of teacher training though the presentation of effective educational models via video or computer simulation, and/or the study of cases, help curtail the daily tasks of an instructor to a certain extent, i.e. in lesson planning, grading, and communication with students, and have all the potential to change not only teaching, but the art learning as well.

Perhaps the most striking thing that can be seen, is that the integration of technology in the teaching field necessarily guarantees a change in traditional teaching models and environments (ISTE, 1998). Interestingly enough, one can observe in the changes proposed in Table 1 (below) that the only some transformations in the teaching-learning environment are really only specific to the introduction of technology itself. The majority of the changes concerned teaching methodology as a whole and do not necessarily have to do with the use of technology per se, although it is true that its use can favour and cause these changes.

Change	Traditional Learning Environment	New Learning Environment
Methodology	Teacher-centered instruction	Student-centered learning
Technology	Single sense stimulation	Multi–sensory stimulation
Technology	Single path progression	Multi–path progression
Technology	Single medium	Multimedia
Methodology	Isolated work	Collaborative work
Methodology	Information delivery	Information exchange
Methodology	Passive learning	Active/exploratory/inquiry-based learning
Methodology	Factual knowledge-based	Critical thinking and informed decision-making
Methodology	Reactive response	Proactive/planned action
Technology	Isolated, artificial context	Authentic, real-world context

Table 1. Changes produced by the integration of technology in learning environments (modified from ISTE, 1998: 2)

It is true that technology and internet are changing the means to acquire information. For example, the introduction of a new technologies have taken us from using one single medium to transmit information to multimedia, from the considerably narrow band to broad band, from access through the net to wireless access, and from the user who had to adapt to technology to the technology actually adapting to the user (WBC, 2000). Other changes associated with technology are expressed in the CEO report (2000b), in which the characteristics of the new media are described, as well as the content in which they are distributed. Specifically, digital content can be accessed fortuitously at any given moment, in any place. It is, therefore, relevant, up-to-date, and authentic. It can be explored at many levels, such that it can be adapted to the needs of every student. It is interactive and stimulating, and can motivate and interest students. It is able to manipulated with adequate bandwidth, is also instantaneous. It is creative and can give way to more active learning for the student and lends itself to imaginative use by the teacher in the classroom.

The question is, then, that as these new technical realities created by the advances in technology and telecommunications have become developed and widespread, their effectiveness in the realm of education has been identified (OTA, 1995; Barron and Orwing, 1995; Bransford, Brown and Cocking, 2002; CEO, 2000b):

Resources for the teaching of complex and abstract concepts, and for team and group work.

Adaptable to students' learning styles and special educational needs. The distribution of content through diverse channels facilitates attention to diverse learning styles. As a consequence, the individualisation of teaching is facilitated, which allows for adaptation to the speed at which the student learns. There are opportunities for feedback, reflection, and revision.

Teachers report that they expect more from their students. They are more comfortable with the students' independent work. They present more complex material. They can adapt teaching to their students and adopt new roles (as guides, aids). Therefore, less time is dedicated to magisterial-type of teaching, and more time is student focused.

Teaching environments based on problems and projects, centred on the students, collaborative, active learning and self-expression on the part of the students are enhanced, critical thought and co-operative learning.

Professional training. Lifelong learning, at any time or place.

Communication skills, developed through networks in small groups or with students with special educational needs.

With respect to the *21st century skills*, collected in the NCREL (2001) and Partnership for 21st Century Skills (2003) reports, the technologies will be able to contribute to the advancement of a literacy for the digital era, skills for inventive thought, effective communication, and interpersonal skills, productivity skills, and of course, basic reading, writing, and mathematical skills.

The *technologies improve* the student's productivity and motivation, creating a more attractive learning atmosphere. It closes the gap between the real world and schoolwork.

What teachers should do to reach this potential

The NCATE (1997) report emphasises the danger produced by teachers who cling to old teaching models, forgetting that they have served them well in the past but that they cannot serve them in the future. It affirms fervently that breaking away completely with the old well-known methods, can be risky, but it is what we need in the present. This article clearly explains what teachers can do to take advantage of the benefits that technology offers the teaching field.

New understandings. Technology changes society, the understanding of work, communications, and our understanding of the development and acquisition of knowledge.

New approximations. Currently, sources to obtain information vary greatly; in the past, the student was limited to books and teachers. Teachers have to teach students how to understand

and how to make use of the new sources (tools and software). In the same way, they should include them as part of their teaching repertoire.
The technologies can help to develop the skills of the 21st century —the skills of the digital era— abilities to think creatively, communicate, and produce, and improve the basic skills (CEO, 2001).

New roles. Teachers should help students to pursue their questions, search, organise, and interpret information so that they may develop abilities to reflect and think critically about the quality of information from the sources.

The technologies will, then, transform the teacher's role. Now more than ever the teacher must become the animating element that encourages the students to ponder, ask questions, learn how to find answers, and analyse and synthesise the results that they find. This requires that teachers be ever more proficient in their subject matter and the means they use to present these subjects.

New techniques in teacher-training. Teachers can attend formative courses, in a non-traditional way: at a distance, with emphasis on collaboration with other teachers and the exchange of professional experiences.

New attitudes. Teachers should adopt a brave, confident attitude toward the use of technology, prepared to take risks and become students along life.

The need to create new skills

Just by looking at the conclusions drawn at the presentation, "Technology in schools: Measuring the Impact and Shaping the Future" held in 2000, and organised by the U. S. Department of Education, one can see the need to transform the art of teaching in order to make it suitable for the challenges presented by the new technologies. (U.S. Department of Education, 2001):

- Technology has enhanced knowledge about the ways in which children think and learn.

- Research shows that, under the right conditions, technology helps to improve the efficacy of a child's learning. The context, then, is key for effectiveness.

- The enormous impact that technology has exerted upon society has changed precisely what students need to know and to be able to do in order to have success in our time. The question is no longer whether or not schools should introduce technology. Rather, what must be questioned is how these technologies should be used, and their success at conveying the desired content in order to improve the student's learning.

- The technologies should be used to measure what and why children are (or are not) learning. Sometimes teachers lack the ability to ensure that their students are actually learning when technology is has such a major role in the classroom and risk that their students lose sight of the academic nature of the use of technology and consider it perhaps too "fun."

In summary, one could say that technology changes *how* people learn, and at the same time, certifies *what* needs to be learned (NCREL, 2001). "Students are natives to cyberspace, where the rest of us are immigrants," says Ruskoff (1996, cited in NCREL, 2001). In this most categorical way, it becomes manifest the technological and cultural gap that can exist between teachers and students. So, it becomes entirely necessary to revamp not only *how* one teaches, but also *what* content is being taught. With the same understanding, the 1990's teemed with reports proposing the skills necessary for technological sophistication in the 21st century. The North Central Region Education Laboratory (NCREL, 2001) synthesises part of these works[2] about the abilities or skills that should be taught in order to prepare students: literacy in the digital era, inventive thought, effective communication, and capacities for high productivity. A more recent report highlights six elements that should characterise learning in the 21st Century: emphasis in core subjects, emphasise learning skills, use 21st Century tools to develop learning skills, teach and learn in a 21st Century context and use 21st Century assessment that measures 21st Century skills (Partnership for 21st Century Skills, 2003).

2. THE USE AND INTEGRATION OF TECHNOLOGY

Factors that influence the use of technology

Some of the barriers identified in 1995 that prevented teachers from using technology were (OTA, 1995: 19):
Insufficient time to gain experience with the new technologies, share experience with other teachers, plan, develop lessons using the new methods that the Information and Communication Technology (ICT) incorporates, and attend seminars and information sessions.

Access and cost. In addition to the limitation of hardware and software, other factors affect access. Perhaps technology is not found in or even near the class.

Vision for the use of technology. Schools should have plans on how the technologies will be used in them, and teachers should have a clear vision of the objectives sought by incorporating them into their curricula. At the same time, a political evaluator that encourages the use of ICT is necessary. At this time, the standards do not for an evaluation of what is being promoted with the use of the ICT.

Teacher training and formation. The investment of scanty funds in the area of technology training for teachers is another limiting factor for the use of ICT. Numbers show that the budget assigned to technology is principally dedicated to the acquisition of hardware and software (national survey 92-93 where 55% of the budget went to hardware, 30% software, and 15% training).

The training is centered on the use and proficiency of technology instead of its integration into the curriculum. It is certain that all some teachers want is to improve their own personal computer skills. On the other hand, others only want to know what the computer can do for

[2] For the elaboration of the NCREL (2001) report, the following works have been consulted: ISTE (1998), SCAN (1991), 21st Century Workforce Commission, U.S. Department of Labor (2000, June), Uchida, Cetron and McKenzie (1996), International Technology Education Association (2000), Committee on Information Technology Literacy. National Research Council (1999), American Association of School Librarians & Association for Educational Communications and Technology (1998) and Tapscott (1998).

teaching. Other teachers simply want to know how to manage a class situation and organise activities while including technologies. The training courses should address all of these interests.

Technical and pedagogical assistance. After a few training sessions, the teacher should strive to use technology, but needs to know that he/she can count on someone for help if it is needed. Also, teachers might need some pedagogical counsel about what software to use or how to introduce it in his/her classes.

Beliefs. Teachers are a heterogeneous group that can be polarised into two camps, those who are (and no are) favour changes provoked by technologies in teaching methods. The high-tech teachers are the proponents of the integration of technology into the classroom and the changes in the learning environment that accompany it (co-operative learning, research methods). And the low-tech teachers are who adhere to more traditional teaching models and generally fear that the presence of technology in the classroom will make them likely to lose control of the class. These two opposing "Tech" philosophies influence the use or lack of use of the TIC in different schools.

To this extent the barriers identified by teachers in 1995. In a more recent article written in 2000 that compiles the results of a survey carried out in 1999 among public schoolteachers (NCES, 2000)—the obstacle towards access to computers (78%) still exists, the lack of time to dedicate to learning how to master their programs continues to hinder teachers (82%), as well as the lack of time in the school schedule to dedicate to computer usage (80%). Nonetheless, the importance given to these reasons is reduced when teachers who value "the big barriers" standing the way of computer usage (38% scarcity of computers and 37% lack of time to learn how to use them).

The process of acquisition of the new technologies

An important element to take into account when studying and planning the process of implanting and integrating technology on the part of teachers is the existence of behavioural norms in the acquisition of technology.

Moore (1991, cited by OTA, 1995) develops a theory about the process that people follow when adopting and buying an emerging form of technology. According to this theory, various groups can be identified. The smallest group, given the term "innovators," is made up by people who buy new products quickly for the sheer pleasure they take in testing out cutting-edge technological products. These types can also be called "technological" A second, and more numerous group, the "early adopters," cannot be considered "technological" though they do have a sense of the benefits that new technology offers.

According to Moore, there is an gap between the "early adopters" and the next colossal group which 1/3 of the population factors into called "the early majority." This group demonstrates many of the inclinations present in the previous group with respect to their view of the new technology, but these people are guided by a very practical and utilitarian instinct. The members of the "early majority" group tend to be more cautious about investing in something new that has not been proven successful and/or efficient.

A fourth group that exists and is also quite large is the “late majority” that is distinct from the “early” in their comfort and confidence with their own experience with technology. As a result, this group prefers not to utilise new technology until it is absolutely necessary, and standards of familiarity with it are well established.

Lastly, another group identified as “laggards” or the ones left behind, includes all of those who downright reject all new technology.

The norms manifested in Moore’s theory can be applied to teacher population. The challenge would be to eliminate, or bridge the gaps between the educators who strongly favour the implementation of technology and the others who discard it as superfluous to their educational objectives. This prospect is quite complicated as Cuban affirms (1996, p 108) after studying a similar phenomenon that occurred in the transition of the pre-industrial to industrial society[3]. Cuban bases his claims the results of a study completed in 1952 about the integration of industry in society and popular reactions to it.
Basing their interpretation on the experience of teachers, the Apple Classroom of Tomorrow project, (ACoT, 1995: 16) defines the stages of process of the acquisition of technology:

- *Entry*. Teachers struggle to familiarise themselves with basic uses of technology. Students learn to use technology. However, teachers do not use the technology independently, while students do.

- *Adoption*. Educators part from an initial struggle to achieve some success in using the technology at a basic level. They are able to incorporate what they have now comfortable with into their traditional curriculum.

- *Adaptation*. Educators progress from a basic control of the technology to a point where they are able to appreciate and discover its possibilities. The educators then make use of the technology to enrich their curriculum.

- *Appropriation* occurs when the [teacher’s] dominion over technology allows for him/her to use it in a variety of situations. Technology is integrated, and its unique capacities are exploited.

- *Invention*. Educators develop new technology-based learning environments.

[3] People are resistant when changes that threaten their security, or when they do not understand them, or are forced or obligated to change. In the same way, when one “subculture” that has demonstrated itself effective in is applied to another “subculture,” it is necessary that the value of the cultural changes be explained so as to avoid outright resistance and opposition by the general and perhaps lesser informed public.

The steps to follow in order to integrate technology

In the OTA (1995) report and Barron and Orwig (1995)'s work[4] both establish an approximation in order to facilitate the integration of technology. A summary of the contributions of these two writings includes the following:

INVESTMENT IN TECHNOLOGY

Access to technology. Since the teacher can easily become exasperated upon having to attend seminars in order to become familiar with the technology that he/she may not even want to use in class, more effective resources must be designed that are interesting to the teacher and demand great effort on his/her behalf. In short, more appropriate technological resources need to be facilitated.

Instructive vision. When equipment or software need to be bought, an educational criteria should prevail over a information technology standards. Technology in the classroom should be based solely on educational objectives. In the first place, the objectives must be clarified, and later the technology that will enhance these objectives should be sought. Technology should be used only when appropriate.

Acquiring technology gradually. Technology evolves rapidly, so it is recommendable that new hardware not be bought until the old is obsolete.

Establishing *agreements* with public and private companies, universities, administrations, and any institutions that would be able to donate time, money, and hard/software.

Researching freeware and shareware.

Researching technical support. Before buying software or hardware, it is important to ask what kinds of technical assistance are offered.

INVESTMENT IN HUMAN RESOURCES

Redefining training. Some teachers can learn well on their own, while others might need to learn in formal seminars or courses. Seminars can be the best way to show new technical developments, distribute written materials that can later be used as reference, exchange and discuss ideas about strategies for implementing technology in the teaching milleu. A good staff will have to be able to adapt different ways in which teachers would have to become familiar with technology.

Technical and pedagogical assistance. a) The use of technology will not in itself be sufficient in order to fully renovate and innovate teaching methods. If the goal of using technology is to change they way that educators teach, and the way in which students learn (adopting co-operative learning or teaching based on research and projects), then teachers will need help and training in employing new methods. b) More than one person from each school would need to receive such training so as to avoid the emergence of technological "gurus." c) Some teachers would have to be trained to specifically serve as reference for the other teachers when they need help, and even as mentors for them. d) It would also be helpful to the teachers to

[4] A summary of this article was referred to, found on the following web page: www.quasar.ualberta.ca/edpy202/edtech/implemnt.htm, accessed in August 2001.

have some of their students receive training for additional support. The students who have a particular knack with computers can be used as sources of aid for their classmates, and also as technical support for the teacher.

SHOWING MODELS

Creating points of reference in schools so that the teacher can have model practices to follow.

Employing schools and technology classes (Model Technology Schools and Classroom) that can serves models for other institutions. The OTA (1995) report presents an example from the Monterrey School where: a) there is a Technology Demonstration Centre where the expert teachers teach the others what they do; b) technology training seminars are taught; c) expert teachers produce documents, videos, and CD-ROMs to show their colleagues how to use the technology in their lessons.

Asking other educators for advice. Perhaps the best way to learn how to integrate technology is to ask colleagues who have already discovered how to do it successfully. A great way to obtain such advice is to join a distribution list where experiences are shared with fellow teachers who have tried and/or are learning how to incorporate technology into curricula.

Subscribing to publications. Specialised journals about educational technology can keep the teacher informed about new developments, recent research, products, and other ideas about integration.

Establishing a Technology Resources Centre.

COMMUNITY SUPPORT

The objectives of the introduction of technology should be communicated to the school community and administration, and should be considered in the school budget. To this end, a sustaining action must be made in order to include technology in the culture of the school through: the revision of curricula, offering training programs, incentives, developing ways to evaluate new programs, designing a budget (to facilitate the acquisition and maintenance of hardware and software, teacher and administrative training), and flexibility in the school's organisation—the traditional educational environment necessarily should change since the purpose of the technology is to focus teaching on the student.

BALANCE BETWEEN THE USE OF TECHNOLOGY AND PERSONALIZED INSTRUCTION

Balance between the "high tech" and "high touch". In teaching, human contact is essential. For this reason, even though the most advanced technologies are applied to the educational environment, the teacher should not lose the personal relationship with his/her student. In other words, technology should not replace the teacher.

IN SUMMARY. The CEO Forum report proposes only three steps to integrate technology in schools (CEO, 2000b): First, identification of educational goals and the union of these objectives to the digital content. Technology is not a sort of panacea, and it will only be useful if it is used to realise certain objectives. Second, selection of students' results and standards brought into practice by means of digital content. Each state has particular standards that schools should consider when designing their curricula. Third, measurement and evaluation of results along with standards, and adjusting them as necessary.

The same report establishes a series of questions to which institution should consider in order to determine its success in integrating digital content (see CEO, 2000b).

3. TRAINING FOR FUTURE TEACHERS

Teachers constitute the element that defines the quality of instruction (CEO, 1999). A teacher's technology training should never cease; rather, it should continue throughout his/her professional career as technology itself is constantly evolving and expanding. As has been mentioned in previous sections, educators need to know much more than simply how to use machines and software. Training should combine opportunities to learn formally and informally.

Teacher technology training in the United States typically follows three steps or phases: initial training in colleges and universities (pre-service), earning of a license, and continual training over the course of a career (in-service). With respect to the training offered to teachers while exercising the profession (in-service), it is good that the sessions, seminars, and courses that they attend be staffed by IT assistance and/or another mechanism that answers any questions and dispels any doubts that teachers might have.

There is one constant fact: before the 2008-9 school year, the U.S. will need to hire 2.5 million new teachers to replace retirees. (Hussar, 1994, cited in ACE, 1999). This anticipation is signalled by the majority of scholars when making reference to the absolute necessity of training future teachers (pre-service) well for the use and integration of technology and also to attempt to make up for the lack of training that current teachers have. This is the reason why there are a number of reports that review the state of schools of education, so as to assess up to what point they train future teachers in using and integrating technology in teaching.

The state of Schools of Education

There are two reports that analyse the situation of the Schools of Education: one produced by OTA in1995 and another done by the American Council on Education (www.acenet.edu), elaborated in collaboration with the Association of Colleges for Teacher Education (ACENET, 1998; cited in ACE, 1999). The principle conclusions are the following:

Firstly, the way in which the Universities and Colleges prepare teachers is vital for the improvement of schools. Teachers teach the way they were taught. To that effect, the CEO report (2000a) points out that, the United States have a long road ahead. Children of the Digital Era are being taught by teachers prepared with techniques from the Industrial Era. The conclusion is that the quality of teacher training in American Colleges is inadequate for the present times.

The second conclusion concerns the technological preparation received by future teachers in the Education Schools. Results show that programs of study simply do not place enough emphasis on the use of technology in the classroom, and consequently future teachers do not receive the preparation that they need to teach in the 21st century. Data gathered by a 1999 ACE report manifest the inadequacy of the preparation in order to understand and apply technology to teaching. An NCES (1999b) report concurs, estimating that only 1 out of 4 teachers uses technology. Another NECS article (1999a) observes that only 1 out of 5 teachers felt like they were well prepared to teach in the Digital era. The latest statistics show that only 23% of

teachers felt prepared by their Education Schools, and only a mere 10% felt well prepared (NCES, 2000) (see appendix).

Thirdly, teaching methods associated with the integration of technology usually fall into three categories: discussion/demonstration (theoretically, the use of technology in teaching could be discussed—followed by a demonstration in-class of a successful teaching method—though this demonstration is often weird), practice with technology. For example, in a science course, the teacher should take their students to a computer lab and teach them how the computer functions—using some kind of science program), and professional practice (seeing a class with a known methodology and technology). Graduates of Schools of Education who were surveyed ensured that they were comfortable running various drill and practice software in the classroom, but not multimedia.

Lastly, the final common conclusion that the articles agree upon is that the decision-making on the part of University administrations and faculties is vital in order to improve teacher training.

Difficulties introducing Technology in Teaching Programs

When confronted with the registered data about the scarce presence of technology in teaching programs, some articles inquire about the motives, reasons, difficulties or barriers that have caused it (cfr. OTA, 1995; NCATE, 1997; CEO, 2000a). As can be seen, the majority of difficulties are similar to those identified in the schools the lower level schools in preceding pages:

- The lack of access to resources and extreme sparseness of hardware and software. The majority of departments do not have the means to invest in the necessary technical support to maintain a program with equipped with high-quality technology.

- The lack of staff and/or institutional assistance and support.

- The attitudes and training of the faculty. Sometimes the problem resides in the fact that the faculty does not often speak about the integration of technologies. Rather, many professors see it as a separate discipline—not something that they can work into curricula with a different content. Furthermore, many professors lack the skills to incorporate technology into their own subjects.

- Some Teaching Schools are disconnected with what actually goes on in grammar and high schools.

- The ISTE, AACTE, and the Campus Computing Project (cited in CEO, 2000a) point out that although the Teaching Schools belong to the University Community, they are at a disadvantage and receive less attention than other departments (law, engineering, business, medicine) since their alumni are less influential and affluent, and cannot donate large amounts of money to the school. Also, the majority of Teaching Schools are not accredited (only 38% have accreditation from the National Council for Accreditation of Teacher Education).

Along with the various arguments that these articles put forward –and foreknowledge that 2.5 million teaching jobs will be opening up in the next few years also well pronounced in all– fast-action plans for teacher training improvement are being concocted and will be described in the next section.

Improvement action plans

The proposals to reform the training of future teachers that these articles make are largely directed towards current students of pedagogy. The changes will affect the programs of study for undergraduates as well as graduate students aspiring to be Professors in Schools of Education and will have an initial goal of teaching students how to use technologies. The action plans are summarised as follows:

The first step towards improvement involves training the faculty in Education schools. Two studies, one from the AACTE (1996) and another from the ISTE-Milken Exchange on Education Technology (1998) cited by CEO (2000a), indicate that the biggest challenge for these institutions is training the faculty to implement technology in their speciality area successfully and attempt to teach their students (future teachers) how to use it.

Secondly, introducing technology courses will not solve the problem at hand. Instead, the predominant culture and mentality among Education School teachers and students need to be changed through the creation and development of plans integrate technology into education classes, so that the advantages of doing so can be appreciated (NCATE, 1997).

Thirdly, standards concerning the use of technology at all levels need to be established and introduced (CEO, 1999): 1) Levels of technology integration should be criteria in the standards for accreditation in Education Schools; 2) Education Schools should make pertinent tools and training readily available for their faculty to help them learn how to incorporate technology into curricula; 3) Criteria for the acquisition of teaching licenses should include some mastery of technology and demonstrated ability to make use of it while teaching; 4) Financing technological means in Education Schools needs to become an utmost priority.

As a result of these proposals, many programs for Professors in Education Schools have been funded by the U.S. Department of Education, and standards for technology use among teachers and students well-established.

The project Preparing Tomorrow's Teachers to Use Technology initiated in 1999, by the U.S. Department of Education has financed more than 400 different projects which aim to reform Education Schools and ensure that current Professor and future teachers alike know how to make technology work in the classroom and establish technological standards (cfr. htttp://www.ed.gov/teachtech/).

The International Society of Technology Education (ISTE) creates national standards insofar as technology as an academic discipline is concerned (National Educational Technology Standards, NETS: http://cnets.iste.org). In June of 1998, standards for students' technology were created. In June of 2000 standards were assigned to schoolteachers, and in November 2001 to administrators. Actually, 88% of the United States has implemented these standards in their schools—in 41 of 50 states.

Conclusions

One can observe fairly easily some of the ideas that have been repeated throughout these pages about the use and integration of technology in the teaching field, the importance of the access to means, computers, software, digital content, and internet connections, and the need for reform in education programs to adequately train future teachers. Some of the measures adopted from the 1990's into the first years of 2000 have taken the following recommendations well into account.

• The project Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge carried out over the 1996-2000 period has been responsible for connecting the majority of schools to the internet and generally making computers more available (see appendix).

• The ISTE Association has elaborated a collection of standards (NETS) for students (1998), teachers (2000), and administrators (2001) that have been adopted in 41 states (Roblyer, 2003).

• The U.S. Department of Education has sponsored a project since 1999 that finances teacher training programs in Education Schools nation-wide, primarily getting future teachers used to using and current Professors better acquainted with educational technology*: Preparing Tomorrow's Teachers to Use Technology Program*.

The repercussions of Clinton's investment are evaluated in the CEO (2001) report. This work gathers data corresponding to four pillars which the technological success rests upon: hardware, connectability, digital content, and professor/teacher training (see appendix). The objectives to incorporate equipment (or hardware) and internet connections have been covered. However, there is still a lot of work to be done with regard to the other pillars: the integration of digital content and teacher training.

The statistics verify that the availability and price of equipment as well as connectability have improved substantially since 1996 (see appendix). In fact, the ratio of students to computer with Internet access has decreased tremendously from 12 in 1998 to 4 in 2003. In 2003, the ratio of students to instructional computers with Internet access in public schools was 4.4 to 1, a decrease from the 12.1 to 1 ratio in 1998, when it was first measured (NCES, 2005).

On the other hand, if we observe these the data related to digital content, we can appreciate better teachers and future/teachers/students how they use the computer and as a helpful tool in preparing classes and research papers. These statistics concur along with Cuban's study (2001) in the Silicon Valley, where like students, teachers follow a path from kindergarten, to primary and secondary school, and then university, so it is likely to be too late for current professors to have received technology training as a student. Finally, it is no surprise then to discover that there are very few professors who really understand the technology and need to be trained in other ways.

The data from all of the articles presented in this paper reflect and emphasise the idea that the mere introduction of technology in itself does not require any necessary break from traditional teaching methods. Teaching methods are changing though, due to other factors having to do more with teacher training and institutional support. As has been repeated at several points in

this paper, the 2 million potential job openings in the teaching field before 2008-2009 have sort of catalysed a revamping of the future teacher technology training process.

As a final valuation of all of this, it seems interesting to bring the following ideas to light:

• *Redefining teacher training*. Some of the suggestions that the articles offer are: To keep in mind two effective ways to impart technology courses for teachers activities—offering a traditional course for people who are able and want to attend a class as well as providing one online for those who would prefer to teach themselves. Training will include a didactic element in addition to the technical component, and should promote good practices that make technology effective in the teaching-learning process, like staying aware of new developments and methods through distribution lists and specialised journals. A resource centre should be made available to those teachers in training programs where they can access any other information they need, ask questions, etc. Some teachers who have more experience with the new technology should serve as mentors for newer ones, and even technologically apt students should have a role as a technical aid in class.

• *Technical and pedagogical support*. Teachers will feel more comfortable and assured when innovating and introducing technology if they know that they can always go to someone for help if needed. More emphasis has often been placed on the technical side of things, when in reality it seems almost more important that a teacher have a pedagogical support who can orient his/her use of technology and evaluate how coherent it is with the goals of the course. For example, in the PT3-BU project, financed by Boston University's School of Education, depends on the graduate students of educational technology in training Professors of education and supporting them.

• *Not to underestimate the beliefs of teachers*. It is clear that the teachers who tend to adopt technology quickly are the ones who feel comfortable and enthused by active, student-centered methodologies. On the other hand, the most resistant teachers are those who cling to their old magisterial lessons because they are afraid that they will lose control of the class if they abandon the teaching style that they know. This fact suggests that orienting the training of teachers not so much toward the purely technical, but focusing it instead on the positive pedagogical effects the new style would render (co-operative work, problem solving, research, etc.) and becoming familiar with cutting-edge technology in the process.

• Attention to the *process of acquisition of technology*. Cuban's works (1986, 2001) mention how over time, the same mistakes have been committed when trying to introduce technology in the classroom, from the radio to cinema to television. Through these means, the teacher has typically tried to force some kind of technology that he/she has not mastered by any means, does not adapt well to the course's content, and does not know how to benefit from it. To this respect Cuban (1986: 108) gathers the ideas about behaviours of people in the faces of changes that threaten their security, that they do not understand, or if they are forced or obliged to change. In the same way, when a "subculture" has proven itself efficient in another "subculture" it is necessary that its value be explained if resistance and opposition are to be avoided.

• *Support on the part of the institution*. For a plan to be successful at any institution, it is necessary to have their unconditional support—through action plans described earlier, incentives that promote the integration of technology, procedures for evaluating its efficacy

based on student responses and teachers' labour and effort (standards that recognise new skills learned with technology), either through the promotion of teachers (criteria for hiring and promotion). The chart produced by the CEO Forum (2000a) "Star Chart: A Self-Assessment Tool for the Colleges of Education" can help an institution get to know its strong and weak points, and can also help it propose a plan of action based on these results.

• Lastly, it seems important to underscore that *the introduction of technology in itself would not modify the methodology of the teacher*, as the statistics collected in the CEO (2001) report make manifest, and Cuban also affirms in his historical revision (2001). Some of the most interesting potentialities that the introduction of technologies promises the development of more active teaching methodologies, and at times an exchange of the classical teacher and student roles (ISTE, 1998: 2) which have been identified as characteristics of a quality education. In other words, although good teacher can bring technology into the "traditional" environment from time to time and see some of the potential learning advantages, without amending his rudimentary curriculum per se. Nonetheless, it is a fact that the technological novelties that are introduced tend to provoke a change toward a more active, and student-centered methodology and enhance their literacy for the digital age. To conclude, one final thought: if the goal is to really to get the most of the integration of technology in education, then the teacher has to be trained to be innovative with methodology and implement technologies creatively. Without emphasis on teacher training, the teacher will simply replicate old teaching models, and just sprinkle technology in as it suit him/her or even reject it perhaps if its usefulness was not seen.

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Appendix

Statistics compiled by CEO Forum on Educational Technology (2001)

The data that appear below are compiled in the CEO (2001) report that, in the last year of the organisation's existence, attempted to evaluate the results of the 1996 Clinton Plan *–Getting America's Students Ready for the 21st Century: Meeting the Technology Challenge–* to connect all schools to the internet by the year 2000. The numbers correspond to the four pillars of that project: hardware, connectability, digital content, and teacher training. This data are updating with the National Center for Education Statistics report (NCES, 2005).

HARDWARE

The ratio of students to computer, and of computer to multimedia capacities has decreased since 1995. (see Table 2, and Table 3).

year/ratio	Computer	Multimedia computer
1995-96	10:1	24:1
1996-97	9:1	16:1
1997-98	7:1	12:1
1998-99	5:1	10.1:1
1999-2000	5.4:1	9.4:1

Table 2 Number of students per computer[5]

year/ratio	Computer
1998	12.1:1
1999	9.1:1
2000	6.6:1
2001	5.4:1
2002	4.8:1
2003	4.4:1

Table 3 Number of students per computer with Internet access[6]

CONECTIVITY

Both the number of schools and the number of classrooms connected to the internet has grown over last years. Also, the ratio of the number of computers connected to the internet to the number of students has decreased. (see Table 4).

[5] Source: Quality Education Data (2001).
[6] Source: National Center for Education Statistics (2005).

	Public schools connected	Public classroom connected
1994	35	3
1995	50	8
1996	65	14
1997	78	27
1998	89	51
1999	95	64
2000	98	77
2001	99	87
2002	99	92
2003	100	93

Table 4 Percentage of public schools that have internet access[7]

Professional Development

Teachers who received in excess of eleven hours of training per year say that they count on using technologies in their classes. One can see then the importance of continually training, and more importantly how technologies can be used in teaching. (see Tables 5,6,7).

	1998	1999	2000
Use computers daily for planning and/or teaching	47	69	76
Use of internet for instruction	33	54	63
Have e-mail	39	65	77

Table 5 Rise in use by teachers (percentage)[8]

	%
Not at all prepared	13
Some what prepared	53
Well prepared	23
Very well prepared	10

Table 6 Level of preparedness felt by teachers (percentage)[9]

[7] Source: National Center for Education Statistics (2001. 2005)
[8] Source: Market Data Retrieval (2001)
[9] Source: National Center for Education Statistics (2000)

	Use to a moderate extent	Use to a very extent
No training	22	3
Basic technology skills	22	3
Curriculum integration	32	5
Both basic skills and curriculum integration	32	8

Table 7 Teacher use of technology by type of training received (percentage)[10]

Percentage of school or district who has offered professional development		Percentage distribution of teachers who have attended professional development									
		0 percent		1 to 25 percent		26 to 50 percent		51 to 75 percent		76 to 100 percent	
2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
87	82	1	1	42	38	17	18	11	13	30	30

Table 8 Professional development for use of the Internet in the classroom in public schools[11]

In 2003, nation-wide, 82 percent of public schools with Internet access indicated that their school or school district had offered professional development to teachers in their school on how to integrate the use of the Internet into the curriculum in the 12 months prior to the survey (table 8).

Thirty-eight percent of the schools that offered professional development in 2003 had 1 to 25 percent of their teachers attending such professional development in the 12 months preceding the survey (table 8). Eighteen percent of the schools had 26 to 50 percent of their teachers, 13 percent of the schools had 51 to 75 percent of their teachers, and 30 percent of the schools had 76 percent or more of their teachers attending professional development on how to integrate the use of the Internet into the curriculum in the 12 months preceding the survey. Another 1 percent of schools reported not having any teachers attending such professional development during this time frame (National Center for Education Statistics, 2005).

[10] Source: Educacional Week, Building the Digital Curriculum (1999). Teachers who received training in the same year were more likely to use technology.
[11] Source: National Center for Education Statistics (2005)

DIGITAL CONTENT

The students' use of the computer is academically based: to research and obtain information for school projects. Their tendency is to us e it fairly infrequently in school. At the same time, the data shows that teachers make use of the computers and internet to make materials and prepare classes. (see Tables 9,10,11).

Do research to assignments	96	Study for tests	39
Write papers	91	Do non-school activities (e.g. download music)	35
Do homework	62	Take exams	20
Help visualise new concept	60	Communicate with class-mates about schoolwork	19
Practice things learning in class	57	Communicate with teachers	14
Get homework help	44	Communicate with students in other towns about schoolwork	7
Keep up with news	43	Take courses with students from other schools	5

Table 9 Students use of computers at school (percentage)[12]

	4th	8th	12th
Almost every day	9	14	21
One or twice a week	20	24	28
Once or twice a month	17	28	30
Never or hardly ever	55	34	22

Table 10 Frequency of students computer use for schoolwork (percentage) [13]

Create instructional materials	39	Multimedia classroom presentations	8
Administrative record keeping	34	Access research and the best practices in teaching	7
Communicate with colleagues	23	Communicate with parents and students	7
Gather information for planning lessons	16	Access model lesson plans	6

Table 11 Teachers use of computers or the internet at school (percentage)[14]

[12] Source: Educational Week/MDR/Harris Interactive Poll of Students and Technology (2001).
[13] Source: Educational Week, Building the Digital Curriculum (1999).
[14] Source: National Center for Education Statiscts (2000).