# ICT & learning in Chilean schools: Lessons learned

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A B S T R A C T

By the early nineties a Chilean network on computers and education for public schools had emerged. There were both high expectancies that technology could revolutionize education as well as divergent voices that doubted the real impact of technology on learning. This paper presents an evaluation of the Enlaces network, a national Information and Communication Technologies (ICTs) and education initiative designed as part of a series of programs to overcome inequity and quality issues of public education in Chile, by integrating teachers and learners into the knowledge society. Data gathered and the results obtained in four major areas of educational policies – infrastructure, digital literacy, conditions of learning, and the impact on school learning of major national and international tests – are presented and fully analyzed. The strengths and weaknesses of Enlaces as a visible component of the educational system and educational reform are also discussed. Enlaces has provided basic infrastructure tools, connectivity, ICTs, and teacher training to a huge number of schools, but critical results are narrow in terms of classroom learning and no additional competencies have been observed. Data and results are limited by structural bottlenecks in the educational and social system. Finally, the lessons learned after more than 15 years of implementing technology in Chilean schools are presented and fully discussed.

## 1. Introduction

The implementation of personal computers into schools, in order to achieve technology transfer and to support learning, started during the seventies and has progressively entailed special emphasis on computer/digital literacy and technology integration into classrooms. In this realm, diverse school systems have experienced the implementation of an ample range of initiatives, projects, task forces, private and public programs (Coppola, 2004; Fabos, 2004; Sandholtz & Reilly, 2004; Sánchez, 1991a, 1991b; Slator, 2006; Sprague, 2004; Wenglinsky, 2005; Zucker & Kozma, 2003).

Nation wide school ICT programs or projects for school teaching and learning have expanded progressively worldwide (Ramirez-Romero & Galeana, 2006; Rasinen, 2003). Public initiatives have intended to spread the use of computer technology in schools by implementing computer laboratories and embedding actual classrooms with digital technologies to assist and support current classroom learning (Kozma, 2003).

Ibero-American countries have incorporated diverse public programs for ICTs in education. Such are the cases of Spain (National Center of Educational Information and Communication, CNICE) (Eurydice, 2001); Costa Rica (National Program of Educational Computing), (Borthwick & Lobo, 2005); México (*Red Escolar*), Brazil (*Proinfo*) (Mutzig, 2001), Colombia (*Conexiones*) (Zea, Atuesta, & González, 2000), Uruguay (*Integración Tecnológica al Entorno de Enseñanza y Aprendizaje*), and Argentina (*Aulas Interactivas*) (Sunkel, 2006).

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These projects on innovation in education using ICTs have been directly or indirectly accompanied by some literature about the desirable impact of ICT on education.

At the beginning, strongly influenced by positivism, the main focus of researchers such as Dwyer (1980) and Suppes (1980) was to determine "the effect" of a technology "x" on a particular learning or the development of a specific skill. The focal point was to compare the effect of a class with the use of computers (experimental group) with a class without computers (control group). The idea was to probe that learners using computers can learn more, faster and better than non technological ways of learning.

Authors such as Honey, McMillan, and Carrig (1999) suggest that before researching the impact of technologies for learning we should ask why we want to use ICT in education? Can we accomplish the same learning objectives without using ICT? Can we expand the learners' experiences and world views when exposed to teaching practices that integrate ICTs? Can technology help to shape the desired learners? They mention that numerous studies in computers and education do not have a clear educational focus, measure differently the result of learning with ICTs and assume different assumptions for the role played by the teacher in the use of technology in the classroom.

Montgomery (1996) asserts that a set of common characteristics emerge from the research on computers and education that can be summarized as: (1) technology by itself rarely has an impact on learning and (2) this impact can be understood only in context, when linked to a particular social and cognitive context in the school.

Diverse studies stress that when certain conditions are attained the use of ICTs can have a positive effect on teaching and learning. The conditions most cited are: enough access to technology, adequate teacher training, effective curriculum, relevant and pertinent evaluation, stimulating school system, and an encouraging family and community (Norris, Soloway, & Sullivan, 2002; Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

Thus, the two most frequent factors mentioned to assure success in learning with technology are to identify the uses that support learning most effectively and the conditions require of successful learning with technology. ICTs are just tools; their contribution to improve learning depends on how they are used (Chen et al., 2000; Kerr, 1991; Montgomery, 2000; Shields & Behrman, 2000; Wartella & Jennings, 2000).

Since the early nineties, Chile has launched a major national initiative to implement computer technology in schools to improve the equity and quality of education (Enlaces, 1994). The Enlaces network has been considered one of the most systematic, successful and sustainable programs in the region in order to cope with the special geography and culture of the country, including rural, urban, indigenous, and community education (United Nations, 2005).

Enlaces is a national initiative designed to improve teaching and learning, integrating ICTs into curriculum and thus teachers and learners into the knowledge society, in order to help overcome issues of inequity and poor quality in publicly financed education in Chile (CIDE, IGL, & Universidad Alberto Hurtado, 2004). To attain this goal, Enlaces has provided infrastructure and connectivity to public schools, implementing digital resources, in-service teacher training, and pedagogical teaching methodology support since 1992 (CIDE et al., 2004).

The Enlaces budget reached over US$ 123 million between 1995 and 2002. Investment varied between US$ 36 and US$ 82 per student, depending on the number of schools that entered the program year after year (CIDE et al., 2004). In 2005 the Enlaces budget was approximately US$ 18 million, and in 2006 it was US$ 20.5 million. In total, Enlaces has spent more than US$ 200 million in its 15 years of operation (Enlaces, 2006).

Since its conception, Enlaces has functioned as a network coordinated by the Ministry of Education composed of 24 public and private universities, some hardware, software and telecommunication companies and other public and private institutions throughout the country. They assumed active roles in advising and implementing the technology in the schools, training and providing pedagogical support to teachers for technology use and integration into curriculum, and doing some research and development on educational computing.

What is the contribution of Enlaces to efforts for change in the Chilean education? What are the most critical aspects in terms of school learning? What factors contribute to or attempt against the results obtained? Research on computers and education has posed numerous hypotheses concerning the impact of ICTs on learning. National and long term curriculum initiatives such as Enlaces offer fundamental opportunities to describe, analyze, explain, and understand the intertwined process of using and integrating digital tools from real and everyday school settings.

In this work we are focused on the second object of study: the understanding of the processes, results and impact of ICTs in education. This work adds to a previous study (Sánchez & Salinas, 2007) by analyzing the major results of the Enlaces network, its strengths and weaknesses, after more than 15 years of systematic implementation of digital technology, technical assistance, and consultancy in ICT and education in publicly financed Chilean schools. Finally, as a result of the analysis of quantitative and qualitative data, we depict the lessons learned from ICTs implementation, use and integration into school curriculum in Chile.

## 2. Methodology

The research methodology used in this study was a series of in depth documentary analyses of secondary statistical data and information (Gall, Gall, & Borg, 2006; Strauss & Corbin, 1990). This included the intensive use of bibliographic, reference, documentary and research reports and articles that were already published by third party sources (Quivy & van Capenhoudt, 1988).

This methodology allowed gathering a significant amount of information accumulated regarding the Enlaces network and using high scale data published nationally and internationally.

For this purpose, we systematically gathered secondary statistical data and information available about Enlaces, its context, design, processes, results and impact. Data and information were collected from internet open access databases (Scielo, Google, and Scholar Google), institutional databases (OECD, World Bank, UNESCO, and Ministry of Education), restricted access databases, directories and indexes (Academic Search Premier, ERIC, Academic Source, Library, Information Science and Technology Abstracts, SocINDEX) and diverse databases, research papers and books on computers and education.

The unit of analysis was Enlaces, its context, design, processes, results and impact on teaching and learning. The selected material was composed of open access public reports from well established research institutions, research data, national and international statistical data and documents and reports distributed throughout the member institutions of Enlaces by the Ministry of Education.

In each text analyzed we identified bibliographic references that matched the search criteria, and then were included in the following process. This procedure for search and selection of information continued until a saturation point was reached. The method continued until new data was provided, and the process was stopped when information became redundant (Taylor & Bogdan, 1998). In parallel we identified categories of analysis that served to select, classify, and cross-examine data in the documents.

The search and selection method was implemented initially by using wide criteria and then narrowing progressively. The most general categories were the social, political and educational context of Enlaces, its design, description of line of works, evolution through time, coverage, focus, results from objectives and impact.

Previous to using the information gathered we analyzed its reliability, the information source credibility and data accuracy by triangulation. This was made by discriminating the definition of concepts, data analysis, sample methods, ways of asking, and sources of information. When two or more sources had conflicting data on one theme, we selected those more reliable and comparable. This was made by comparing sample bases (comparative sampling units and probabilistic samples were preferred), inquiry forms (comparable ways to ask) and answer categories used for each data source (comparable ways to answer).

## 3. Research findings

Enlaces emerged in 1992 as an experimental initiative within a major program of quality education and changes and improvements in equity. In 1998 this program evolved into national, educational reform and, for the first time, computers and education were formally incorporated into the educational regents (curriculum) as a transversal objective (embedded in the educational reform). This context of school reform has touched deeply the objectives, scope and results of Enlaces.

### *3.1. Enlaces in the context of the school reform*

The national program for the improvement in the quality of education in the beginning of the 1990s was developed in a context of the return to democracy, which offered political support for a process that would mobilize the entire educational system. This was after two decades of changes that were purely quantitative (adding more schools to the system, especially the partially publicly subsidized schools), financial and of a managerial nature, but not pedagogical changes that would aim to improve the quality of education and educational infrastructure. Education came to occupy one of the highest priorities of the last four democratic governments from 1990 to date, and constitutes one of the unquestionable priorities for Chilean citizens. The Chilean educational system had not had a reform process of this magnitude since the 1960s.

The origin of the educational reform was triggered by the national consensus around the urgent need for more equity and quality in Chilean education. The reform involved mainly changes in the regulatory frameworks, increased school coverage, changes in primary and secondary school curriculums, increased pedagogical resources and infrastructure for schools, professional development for teachers, on-the-job training, increased time spent on teaching, increasing student attendance, and school management changes.

All these changes have also been accompanied by an increased educational budget. By 1990, the educational budget had reached 3.8% of national GDP, but in the following years the budget has increased to 6.8% of GDP (in 2004). In 2003, the OECD (Organization for Economic Co-operation and Development) countries had an average budget for education of about 5.9% (UNESCO, 2006).

The increment of investment on education has been as much for public education as for private. By 2004, according to data from the OECD, private investment in education totaled 3.3% of the GDP, while public investment was at 3.5%. On average, private investment in the OECD countries reached only 0.7% of the GDP (UNESCO, 2006).

In 2006, primary and high school education coverage for the population of children and youth in the country was higher than 90% for both primary and secondary education (Cox, 2006). The system attends to more than 3.6 million pre-school, special education, primary and high school students. Of these, 47% attend schools that are administered and entirely financed by the state on a local level (municipalities), 45% attend privately administered and partially public subsidized schools and only 7% attend totally private schools (Ministry of Education, 2006).

This coverage is the result of the massification of schooling from the 1960s to the 1990s, and of a specific initiative to add more schools to the system, especially of the partially public subsidized variety. Quantitative growth in school coverage

made the school system evolve from being oriented to educate only student elites to a massive system that considers a heterogeneous student population.

In the case of Chile this heterogeneity is even higher, considering its high level of social inequity. In 2006, the poorest 10% of the population in the country had only 1.2% of the national income, whereas the 10% richest had 38.6% (CASEN, 2007). Social inequity translates into educational inequity, and changes in education have not been able to compensate strongly enough for the differences in social and cultural capital. Fig. 1 shows the relationship between socioeconomic groups and scores on the national, standardized test to assess learning achievement, called SIMCE. Clearly, the higher socioeconomic groups obtained the highest scores in language, mathematics and science, whereas low income groups obtained the lowest achievement scores.

Furthermore, the Chilean education system displays, in general, low results in international learning achievement evaluations. The Trends in the International Mathematics and Science Study TIMSS (2004), applied in 2003 in 46 countries at the 8th grade level, shows Chilean learning achievement results in mathematics and science lower than most of the countries participating in TIMMS, as well as lower than countries with similar GDP per capita that year, such as Hungary and Lithuania, and lower than the international average (see Fig. 2).

Other international evaluations show that the Chilean adult population has similar poor results in learning achievement, such as the 1998 IALS study (International Adults Literacy Survey), which measures the abilities to understand and utilize information in everyday life for people from 16 to 65 years of age. This test measures the ability to comprehend and use information from editorials, news sources or manuals (prose), the locating and use of information about job offers, maps and graphics (documents), and the application of arithmetic operations (quantitative). In this study, Chile obtained the lowest results out of the 22 participating countries, most of them OECD countries and some with a similar GDP (see Fig. 3). The study showed that a large part of the Chilean population is not able to comprehend or manage even minimal levels of written and numeric information (Bravo & Contreras, 2000).

TIMSS data also shows that 45% of students are taught by teachers who admit to having little confidence in his or her training to teach math. This is three times higher than the international average of 14%. In science, the picture is similar: 66% of students are taught by teachers who admit to having little confidence in teaching that subject, as opposed to an international average of 39% (TIMSS, 2004).

During the reform process, Chilean teachers have changed some of their teaching practices. An OECD report on the country describes a "new pattern (in teaching), whose features include more student activity than in the past, more closeness in

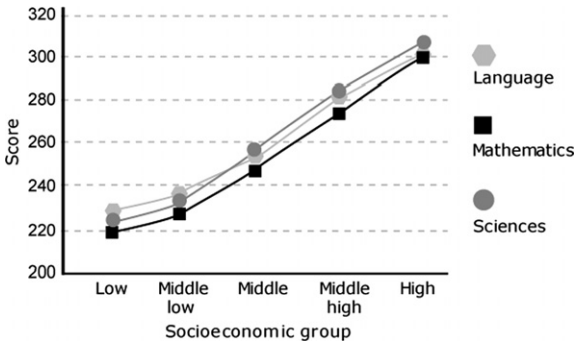


**Fig. 1.** SIMCE, scores for the 4th grade, by socio-economic group, 2005 (SIMCE, 2005).

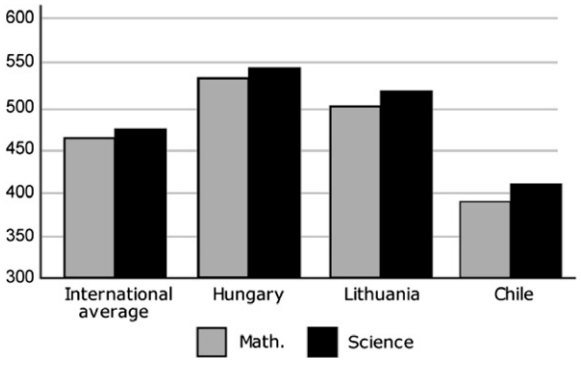


**Fig. 2.** TIMSS 2003, 8th grade learning achievement scores in mathematics and science for selected counties (TIMSS, 2004).

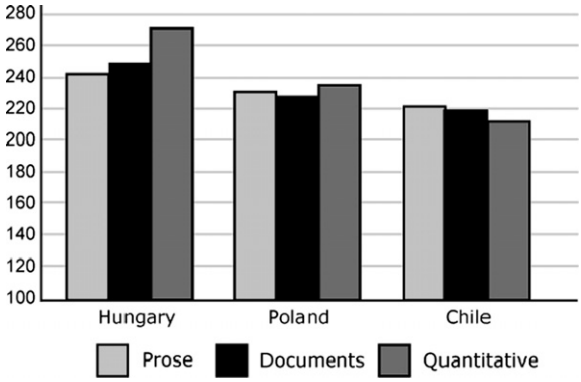


**Fig. 3.** International Adult Literacy Survey (IALS), results for selected countries (Bravo & Contreras, 2000).

their relationships with teachers, and more variety and richness in the use of learning resources, but the whole lacks a focus on achieving learning objectives" (OECD, 2004, p. 123).

Diverse studies that have sought to balance out the advances and problems of the educational reform and, in recent years, have obtained detailed results. One study, published at the end of the 1990s, indicates that between 1990 and 1997, "Chilean boys and girls who go to school, and most of all the poorest children, learn more than they did in 1990: the average SIMCE scores, as much for 4th graders as for 8th graders, have improved by eleven points in the last 6 years" (García Huidobro, 1999, p. 25). However, starting in the year 2000 and up to the present day, observers have noticed what some authors call stagnation in the improvement of quality education (Arellano, 2005; Raczynski & Muñoz, 2007) and others call an increase in the dispersal of the results, which has made for the global level of the SIMCE results to remain practically unchanged, in spite of the increments of investment in education in recent years (Cox, 2006). In any case, the quality of Chilean education is still in desperate need of improvement, as most voices in the society seem to indicate.

In the same way, an evaluation of educational reform made in 1999 showed that the changes have had an impact on the atmosphere and participation of teachers and students in the classroom, and on the improvement of the conditions and resources for learning, but a weak impact on the pedagogic content knowledge of teaching and on learning outcomes (Cox, 2006). The evidence that has accumulated from the evaluations made of the Chilean educational reform, "provided the government's teams with a fundamental lesson: that the creation of capacities among teachers required more than spaces for self-reflection and incentives (monetary or symbolic). The realities of a 'capacity-gap' facing teachers was now clearer, and after the year 2000, the Ministry initiated more direct and explicit capacity-building approaches in its teachers' professional development programs" (Cox, 2006, p.34). That may imply that perhaps more exhaustive, long-term studies and bottom-up interactions between teachers and educational actors in the schools would have allowed officials to better guide the reform and, at the same time, include these people from the beginning as active participants in the reform itself.

### *3.2. Strategy and implementation of Enlaces*

From the start, Enlaces has declared in its initial documents to be part of a higher effort created by the educational reform. In this way, Enlaces has sought from the beginning to contribute to the improvement in the quality and equity of Chilean education (Hepp, 1991).

The Enlaces Project (today the Enlaces network), in its first years, was focused on primary education and was proposed as an experimental project that sought to test the possibilities that ICTs represented for education (Enlaces, 1994; Hepp, 1991; Ministry of Education, 1994b).

The working strategy of Enlaces in the school system can be defined by three attributes: direct intervention in the schools from a decentralized network of institutions, privileged work with teachers in the classroom, and intervention of an incremental nature.

Enlaces is a network of institutions that are coordinated on a national level by a specialized center, dependent on the Ministry of Education. Currently, the network includes foundations, companies and 24 Universities from all over the country. The universities are organized in six regional centers and 20 operational units distributed throughout the country. These universities are responsible for working directly with the schools and the teachers in training, support, distribution of infrastructure, design, development, evaluation and the diffusion of innovative experiences and research in educational computing (Ministry of Education, 1994a). These ICTs and Education Centers, on the wings of the faculties of education and/or engineering, have sought, with different levels of success, to generate knowledge and experiences that take advantage of the constant creativity, imagination and capabilities of institutions that are, in principle, oriented to this kind of work and which are also, in various cases, closely related to the formation of teachers.

The actor that has been most privileged by the actions of Enlaces has been the teacher. In its initial documents, Enlaces indicates that the projects of educational computing that have been internationally successful have centered their efforts on

strengthening the work of teachers (Ministry of Education, 1994a). The hypothesis is that, through the teacher, a transfer of training to the students would be achieved, as well as an active appropriation of pedagogical practices with ICTs (Ministry of Education, 1994a). The centrality of the teacher has meant that they are the beneficiaries of the training, the central actors in the innovation projects and who, in general, fulfill the management, operation and maintenance functions of the computer laboratories located in the schools. To do this, Enlaces has concentrated its training efforts and long term support on teachers and their schools (Ministry of Education, 1994a, 1994b). Training, during the first years of Enlaces, was concentrated in few classroom sessions for teachers of primary education.

In 1995, the first pilot program for high schools was developed, for training teachers in the teaching of the use of computers, and of productivity and communication tools. In 1996, the massification of the Enlaces project began, including primary and high school, widening the reach of and formalizing the training program. In the first year of training, Enlaces gradually included topics like basic uses of computers, productivity tools, educational software and communication (Internet, since 1998). During the second year, pedagogical applications of ICTs were introduced (see Fig. 4). Later, in 2004, after the first two mandatory years of Enlaces, the Networking Enlaces was incorporated to maintain the pedagogical and technical assistance to the schools and course offerings were made slightly more flexible by incorporating a series of training seminars on technology integration and didactic applications, which would allow the teachers to deepen their knowledge of specific pedagogical tools and techniques (see Fig. 4).

This training system gave shape, over the years, to that which was offered to schools until 2006, and is graphically displayed below (see Fig. 4). From the year 1996, when a school entered the program, a process of teacher training was initiated that lasted for 24 months. During the first year, the teachers attended 36 h of in-class training on digital literacy. During the second year the teachers attended 57 h of in-class, dealing with pedagogical uses of ICTs. At the end of this period, teachers were offered several seminars that they could take according to their interests and needs. At the same time, the schools received hardware, software and technical support (see Fig. 4).

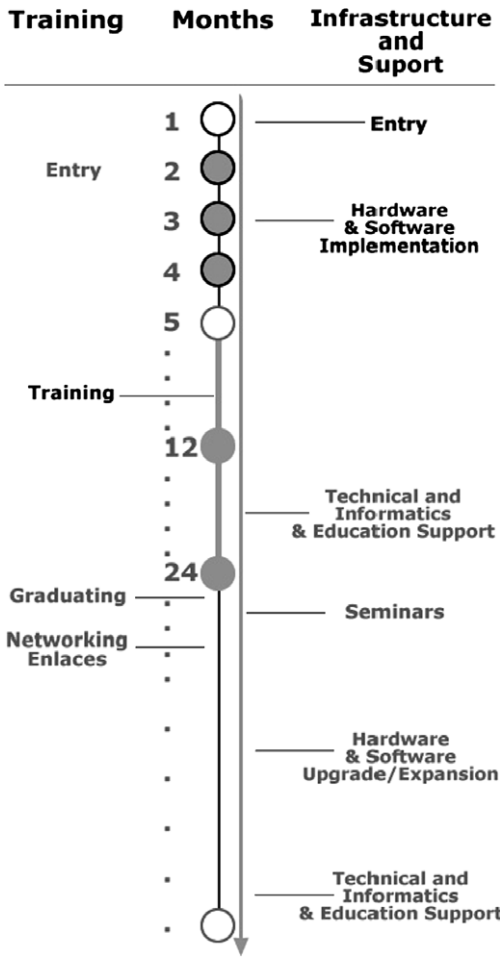


**Fig. 4.** Organizational timing of the training, endowment of infrastructure and pedagogic and technical support, and since 2004, networking Enlaces for continuity.

Sunkel (2006) describes the preeminence of investment in computer equipment and software over that in training during the first years of Enlaces. Starting in 2001, according to Sunkel, this relationship is modified when training and technical assistance represents a little more than 50% of the program's expenditures.

Another key element in the design of Enlaces has been a strategy of incremental intervention. The project emerged in 1992 as a pilot project (Interschool Communications Network), designated to test the possibilities, limits and costs of incorporating technology in the classroom environment. From the knowledge gained during this phase, the process of massification was designed and implemented, occurring from the start of the second half of the decade (Enlaces, 1994). This incremental mechanism is also reproduced in the more specific and focused programs within the Enlaces umbrella. The incorporation of computers into rural schools, the opening of schools to the communal use of ICTs infrastructure, and the design of models for the use of ICTs in the classroom are all programs that started out on a small scale to then become bigger and eventually massified in consideration of the lessons learned (García Huidobro, 1999).

### 3.3. Enlaces results

Enlaces has distributed computers and other ICT infrastructure to 10,000 schools, which means 92% of publicly subsidized schools, fulfilling the program's objective.

Computers are mainly installed in specialized labs, where 2 or 3 students share one computer. Currently, the average ratio in schools is 30 students per computer (Enlaces, 2006). This is a fine ratio when comparing Chile's student/computer ratio with other Latin American countries (see Fig. 5), but it is a low ratio when compared with OECD countries, and with the amount of computers that would be needed to ensure enough computer access time for each student. Currently, there is a large government investment aimed at improving this situation, by increasing the ratio to 10 students per computer in the year 2010.

When a school enters into the Enlaces program, it is provided with a certain quantity of computers in accordance with its enrollment. In general, the schools with less than 100 students receive 3 computers, those with between 100 and 300 students receive 6 computers, and those schools with over 300 students (which are about 42% of the total number of schools) receive 9 computers. This basic endowment of equipment is increased over time, through programs of increasing the quantity of computers provided by the same program, and with the very significant support of other public and private institutions. In the year 2002, 40% of the budget for the equipping of schools came from sources outside of Enlaces (Enlaces, 2002).

Even though there is infrastructure installed in the schools, the real possibilities that the students have to use it are still much less than what is desired. One study, performed in 2004 on Enlaces schools, shows that the primary education teachers use the computers with their students for two hours a week (Fig. 6), while high school teachers use them for 3 h (Hinostroza, Labbé, & Claro, 2005).

Another study done in 2005, with students that are not all in schools belonging to the Enlaces network, shows that 41% of the students do not have access to the Internet in their school (Fig. 7), be it because there are not any computers or Internet in their school, because they are prohibited to connect to the Internet, or because they simply never use the Internet in practice (Adimark, VTR, & EducarChile, 2005). In 2006, 80% of Enlaces' schools were connected to the Internet, 60% of all schools had broadband connections (Enlaces, 2006).

If we compare these results to international data, such as SITES M1, the Chilean educational system shows some strong aspects: in teacher training coverage, internet access and computer updates and renewals in the schools, Chile out performs countries with a higher GDP such as Israel and the Czech Republic (see Fig. 8). This, undoubtedly, is a consequence of the longitudinal implementation and use of digital technologies in the schools under the Enlaces framework since the early nineties.

To assure the correct functioning of the computers installed in the schools, Enlaces provides them with support through preventive visits to schools and online technical support. Besides this, Enlaces trains a teacher or a computer related

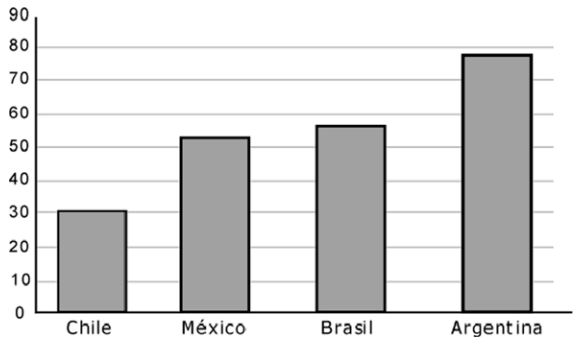


**Fig. 5.** Student/computer ratio in some Latin American countries (Enlaces, 2004).

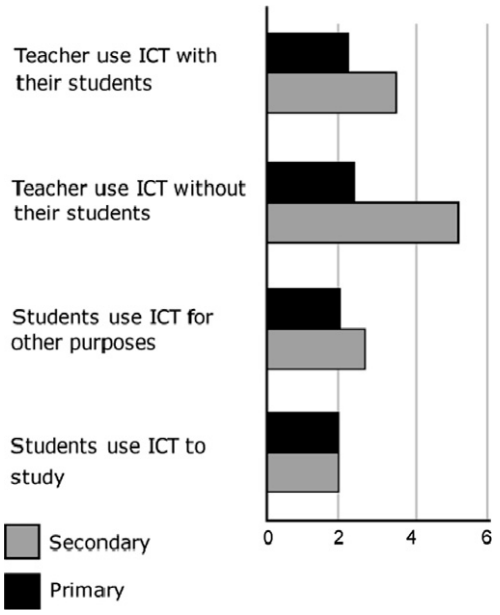


**Fig. 6.** Time of ICT use in Chilean schools (Hinostroza et al., 2005).

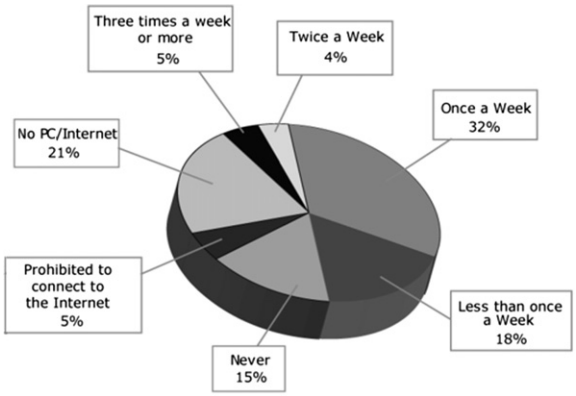


**Fig. 7.** Frequency of school internet access (Adimark et al., 2005).

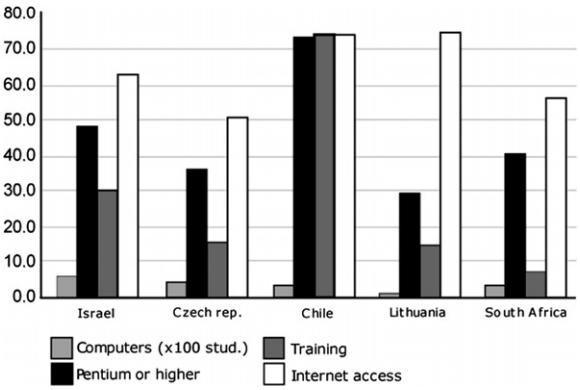


**Fig. 8.** SITES M1 National results in some ICT related issues (Enlaces, 2002).

professional from the schools that belong to the network, to act as lab coordinator. The coordinator must administer the use of the computer lab, maintain the functioning of the computers in a good state (they have been trained to solve basic and medium level technical problems) and to help their colleagues with the educational use of ICTs.

Enlaces has provided training for using computers to 82% of the teachers from publicly financed schools. In a test of the ability to use software and computer applications implemented in 274 schools in the country between 2001 and 2002, it was found that the teachers obtained a level of achievement between 44% and 61%, depending on the amount of time that they have been in Enlaces and the kind of school in which they worked (Arancibia & García, 2002). Another study obtained similar results when it applied the same test to a larger sample of 560 teachers in 2003: those teachers who had been trained by Enlaces obtained an average of 57% as a final score, under circumstances in which a minimum score of 75% was required to consider that a person has an acceptable level of TIC operation ability (CIDE et al., 2004). In addition, the SITES study shows that 70% of the high school principals and 73% of primary school principals think that the integration of computers into classroom pedagogical practices is the most difficult task at the school level. Both these percentages are more than 10 points higher than the international average (59% and 58%, respectively) (Arancibia & García, 2002).

In the case of the students who attend the schools that form part of the Enlaces program, a study of the ability to use different applied software programs in 2002 showed that the percentage of correct answers oscillated between 26% (use of spreadsheets) and 52% (operation of Windows). The percentage of correct answers for the word processor reached 50% and those for the Internet and email use reached 49% (Arancibia & García, 2002). In the study of Adimark et al. (2005), it was found that 57% of the students from schools, in which not all belonged to the Enlaces network, declared to know very little or nothing about navigating the Internet.

Teachers are enthusiastic, but the data reveals less sophisticated and less intensive use of ICTs in their everyday teaching practices. They have high expectations about the contribution of ICTs to education. A number of studies show that teachers have high expectations, or at least think that ICTs have positive impacts on various key dimensions of education: teaching practices in the classroom, student learning, administrative and managerial labor, professional teacher development, student preparation for the work world, abilities for the information society, social and symbolic integration (Arancibia & García, 2002; CIDE et al., 2004; Salinas & Sánchez, 2007). As the preceding number show, however, there is still little intensive and profound use of ICTs in the classroom, and a superficial, pedagogical use still persists among teachers.

Enlaces has provided general purpose tools and educational software licenses to schools since its first years of operation. During the last several years, digital educational resources have been provided mainly through the educarchile portal. Recently, a new strategy to improve the use of ICT resources in the classroom has been set-up. Universities and other institutions are working to develop models for ICT integration into specific curriculum subject matters such as science and mathematics. The models include technology, teaching methodology, learning objectives, teaching resources and tools for student learning assessment.

One of the Enlaces program's most important results is higher equity in student and teacher access to digital technologies. Despite some weaknesses, such as the time of use and the number of computers in schools, students from deprived families can access computers and Internet in a context where they would not otherwise have access. Fig. 9 shows that a great deal of the poorest young people (under 21 years old) does not have access to Internet at home, but they do have access to Internet at school (PNUD, 2006). As a consequence, this access conveys two things: a symbolic form of integration (at least in the field of digital technologies) and a process of the social transmission of some ICT skills and knowledge into the student's family (Salinas & Sánchez, 2007).

The schools are fulfilling a fundamental role in offering privileged access to new technologies, which is important for Chilean students who still cannot have these resources in their homes. In this way, Enlaces is one of the most important public policy for decreasing the digital divide in the country (PNUD, 2006).

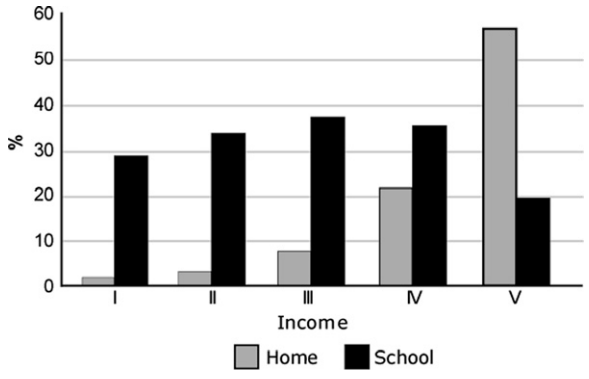


**Fig. 9.** Internet access for young people by income (PNUD, 2006).

## 4. Conclusion and further work

During the last two decades, Enlaces has been one of the most visible educational programs in Chile. It also has been a systematic and longitudinally implemented program to use and integrate computers into school curriculum with permanent support from across four governments during the last seventeen years, involving an increasing injection of important public funds. Currently, Enlaces has spent near to 250 million USD over almost 15 years.

Enlaces has been successful in the first layer of the insertion of computers used for educational purposes: to install computers in schools, provide Internet connectivity, train teachers in educational uses of digital technology and specialized consultation on the use of these. The visible results that have been obtained have provided a lot of political legitimacy for the program, which has been very important in order to maintain and increase the allocated resources.

Nevertheless, Enlaces has obtained heterogeneous results in the digital literacy of teachers and weak results in ICT integration into curriculum, especially in the everyday pedagogical practices of teachers in the classroom. In this way, Enlaces has attained more success in the first stages of ICTs integration into teaching practices described by Sandholtz, Ringstaff, and Dwyer (1997). According to these authors in the stages of entry and adoption teachers begin to use ICTs in the classroom still relying heavily on technology with low pedagogic meaning. In Enlaces these stages have been marked by a high investment in infrastructure and training. Authors have encountered that by centring first on curriculum rather than on technology teachers are likely to use technology more effectively and creatively in their teaching, and thus move quickly to more productive and inventive uses of technology in the classroom (Sandholtz & Reilly, 2004).

Even when one of the purposes of Enlaces is to use technology to improve the quality of education and, along with it, pedagogical practices and student learning, the focus has been more on learning outside the classroom rather than within it. Centered on computer lab activities and training for teachers only it has, as such, lost its way for the use of TIC's to assist with learning inside the classroom, embedded in the methodology, pedagogical practices, activities and learning.

Enlaces is based on the idea that teachers will be able to transfer the use and application of digital technology to their students, and that the students, as digital natives, will utilize these technological tools daily, without considering that this knowledge is not formal and systematic, which goes against the productivity of their academic activities. The literature with regards to this is quite explicit in its indication that to use technology daily (cellular phones, computers and PDA's), does not imply *per se* that this technology is used and appropriated correctly, taking advantage of its maximum potential for work in everyday life and academic pursuits (Cuban, 2001; Postman, 1993, 1995). Even though digital literacy is not central in educational computing, studies indicate that it constitutes the base (together with a dominion of active learning methodologies) to successfully achieving ICTs integration into curriculum (Roschelle et al., 2000).

To do that, Enlaces should utilize the best learning practices with technology more strongly, as a model for those that form a part of the community of Enlaces schools. Along the same line, not all the schools should be obligated to utilize ICTs and incorporate themselves into Enlaces permanently in order to achieve ICTs integration into curriculum in the schools that are committed to do so. Perhaps, after having achieved digital literacy, only those schools with a delineated project of educational computing, with a clear commitment by the entire community, with clear goals, objectives and deliverables, and with demonstrable accountability should be able to enjoy the endowment of new Enlaces resources and professional support in educational technology.

Enlaces must go beyond a "one size fits all" program model, without taking important nuances into account, such as the different Chilean geographical regions where there are clear cultural differences and idiosyncrasies. In spite of current programs using ICTs in rural and indigenous populations, Enlaces needs more local, focused and long term initiatives; more adjustments, understanding, and feelings with the schools' needs and cultures.

The above means giving more relevant room to take on demands, ideas and initiative that come from the teacher and, especially, the students. In this there is not only an enormous source of good and new ideas, but it would also permit a more substantive and active participation and commitment from the principal actors in the educational system. The student protest of 2006 also expressed an effort to achieve the recognition and effective participation of those who construct learning in their everyday experiences. The history of technology is too full of experiences in which innovation has surged more from garages and less from offices, and whose protagonists generally use sport sneakers more than neck ties. Therein lays a source of wealth that cannot be left out (Noblitt, 1997).

One job that Enlaces must undertake is to penetrate the classroom and evaluate the results that are produced there with the use of digital technology. In this way, the impact analysis of Enlaces must go beyond a subjective report that the actors make with respect to their practices with ICTs. To penetrate the classroom also means to study what and how teachers form their pedagogy with ICTs, in the context of the school. An urgent task is to implement measurements for the achievements of concrete jobs and actions performed with the technology (and not of the mere perception of the actors), for the digital literacy of teachers and students, to be able to act in consequence and perform the necessary adjustments in order to achieve the next level: the ICTs integration into curriculum.

In 2006, Chilean students protested against the unsatisfactory quality of school education. After 17 years of the implementation of educational changes, they protested for the same reasons that triggered the educational reform: a quality education for everyone. The British newspaper The Guardian contained the opinion of one student leader that expresses the meaning of the protest quite well: "In any other country, the fact that 5000 students are marching through the streets

demanding a better education would be the object of national pride", said María Jesús Sanhueza, 16, a spokeswoman for the students. "The government should be thanking us, not beating us down" (Franklin, 2006).

Educational reform and Enlaces could now be facing structural problems in the educational and social system. We have more and better technological equipment, more teachers in training, more student and teacher access to technologies, a diversity of programs (such as networking Enlaces with diverse technology integration seminars after two initial years of formal training and implementation, rural Enlaces, community Enlaces, and others) as well as more projects (innovative methodologies in science, mathematics, language as well as the use of mobile technologies and games in education), but currently the urgent priority for the whole society is to improve student learning as well as effective ICT integration into the school curriculum.

As was shown by formerly cited national and international studies, the structural problems of Enlaces are: (1) an inequitable social system, (2) an inequitable educational system, and (3) a low degree of family level cultural inheritance. At the same time, as previously stated, Chilean education has low learning achievement results, and international reports evidence that many teachers display some pedagogical weaknesses in both content and methodology.

These structural elements configure a context that weakens the fundamental bases for an adequate deployment of ICTs in learning. On one hand, we have a system that has weak foundations (literacy) for performing adequately in a knowledge-based society. On the other hand, we have teachers with weak knowledge of teaching content and use of contemporary pedagogic methodologies who compromise the effectiveness of ICT integration into curriculum. The enormous efforts put forth in the training of teachers have not been able to revert these weaknesses in the teachers, because they have had less focus on ICT integration into curriculum and have left the formal training of the students in the use of ICTs aside.

This "structural block" goes beyond the possibilities of Enlaces for action, and touches on aspects related to the initial and permanent formation of the teachers in didactic areas, and the subject matters that they teach. To effectively deal with this, a diagnostic and more profound knowledge of the contexts of technology adoption and integration is required: the teaching practices, strengths and weaknesses of the teachers, student practices and their way of relating to the technology, cultural and social heritage of the different actors, among other things.

Enlaces set up ICTs as important components for educational reform, and contributed to the creation of a national dialogue about the information and knowledge society and new ways of learning in accordance with such developments. Educational reform has been a fairly good context in which to install ICTs in schools, because teachers, parents, principals and students are already mobilized by the changes. Nevertheless, an ICT policy must be articulated together with other reform policy. Otherwise, schools will have diverse changes without proper articulation, and they would probably end up with organizational stress.

The most important job for Enlaces currently, as a whole, is to achieve that the use of ICTs could have a more active role in the improvement of student learning. This is an idea that Enlaces propagated implicitly and explicitly to the different actors in Chilean society. Without a doubt, this is a complex job because, in general, there are not many research based and scientific evidence in the literature on the subject that indicate that the use of ICTs help to improve the learning of a certain subject matter. This being the case, to even begins to close in on this topic, there are two fundamental tasks.

The first is to more clearly position the distinct contribution of this technology for education in the technical and political discourse, which means a profound national and international state-of-the-art in using digital technologies for learning, which would seem to indicate that the improvement provided by the use of this technology goes more along the lines of supporting the development and use of general cognitive abilities than with the achievement of higher/better learning of the content of a specific subject matter.

The second task is to explore such contributions and limits of ICTs that are left out of the traditional measurement parameters for learning. Until now, Enlaces has been conservative in thinking that the effect or impact of ICTs can be measured through the eyes of 19th century education, when in reality we must look at it with other parameters: instead of thinking that knowledge is something stored in the minds of individual beings, we should think that knowledge is something that is found in the networks asserting distributed cognitions to which one has access using technology (Salomon, 1993). It is now time to consider that the skills for the analysis and synthesis of information and knowledge cannot be separated from the tools that we use to do so.

Future work should consider the advances in the technology and the lowering of prices reconfigure the efforts that Enlaces must make in terms of infrastructure. On one hand, the panorama of ICTs today does not stop with just computers in a laboratory or one to three computers integrated into the classroom. Promising digital devices (cell phones, handhelds, smartphones, Ipods) can widen the possibilities for integrating ICTs into school curriculum but using new and non traditional learning and social spaces. Problem, project and game-based school programs, e-Learning, multimedia learning, and interactive virtual environments can also enrich the Enlaces experience. For this reason it is important to identify through quality research and scientific evidence the distinctive contribution and educational added value that the implementation of these new genre of technology-based learning initiatives and the use of each one of these new devices could have, and to act accordingly. On the other hand, wireless connectivity opens enormous possibilities to offer Internet access in geographically isolated zones, and to lend mobility to school work (Salinas & Sánchez, 2006, 2007).

Finally, in the short-term future the Enlaces network should include more ICT industry involvement and R&D related to Enlaces. Action, longitudinal, experimental (qualitative/quantitative) research is needed. Neither of these is as vigorous as we would expect from a rather large, national and critical network like Enlaces, with substantial public financial resources involved. Research is highly needed in Enlaces to inform and enrich school practices with technology. An initiative such as

Enlaces needs to get feedback on its methodologies, resources, models, and even training, in order to develop best practices to feed its roots, platforms and frameworks. To do this, research, clear achievement results and support on scientific evidence should accompany all Enlaces programs and projects.


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## References


Adimark, VTR, & EducarChile (2005). *Indice de generación digital. Radiografía de la digitalización de los niños chilenos*. <http://www.educarchile.cl/UserFiles/P0001/File/articles-100483_estudio.ppt>.

Arancibia, V., & García, C. (2002). *Enlaces: Fortalezas, debilidades y proyecciones futuras* (unpublished report). Santiago.

Arellano, J. P. (2005). *Prioridades estratégicas para mejorar la calidad de la educación en chile* (unpublished report No. 28). Santiago: CIEPLAN.

Borthwick, A., & Lobo, I. (2005). Lessons from Costa Rica. *Learning and Leading with Technology, 33*(2), 18–21.

Bravo, D., & Contreras, D. (2000). *Competencias y destrezas básicas de la población adulta. Chile, 1998*. Santiago: Departamento de Economía, Universidad de Chile.

CASEN (2007). *Distribución del ingreso e impacto distributivo del gasto social 2006* (unpublished document No. 2). Santiago: MIDEPLAN.

Chen, M., Healy, J., Resnick, M., Lipper, L., Lazarus, W., & Dede, C. (2000). Five commentaries: Looking to the future. *The Future of Children: Children and Computer Technology, 10*(2), 168–180.

CIDE, IGL, & Universidad Alberto Hurtado (2004). *Evaluación en profundidad programa red tecnológica educacional enlaces: Informe final*. Santiago: Ministry of Education.

Coppola, E. (2004). *Powering up. Learning to teach well with technology*. New York: Teachers College Press.

Cox, C. (2006). *Policy formation and implementation in secondary education reform: The case of Chile at the turn of the century*. Washington, DC: World Bank.

Cuban, L. (2001). *Oversold and underused: Computers in the Classroom*. Cambridge, MA: Harvard University Press.

Dwyer, T. (1980). The fundamental problem of computer-enhanced education and some ideas about a solution. In R. Taylor (Ed.), *The computer in the school: Tutor, tool, tutee*. New York: Teachers College, Columbia University.

Enlaces (1994). *Plan de informática educativa para todas las escuelas básicas gratuitas de chile* (report). Temuco: Instituto de Informática Educativa.

Enlaces (2002). *Estudio internacional tecnologías de información en el sistema escolar. Sites, el caso de Chile* (unpublished report). Santiago: Enlaces, Ministry of Education.

Enlaces (2004). Tecnologías para la educación en América Latina: Enlaces, Ministry of Education. Primera Reunión de Ministros de Educación de América Latina Sobre Tecnologías para la Educación.

Enlaces (2006). *Planificación Estratégica, Enlaces, Centro de Educación y Tecnología*. Santiago: Ministry of Education.

Eurydice (2001). *Information and communication technology in European education systems*. Brussels, Belgium: Eurydice.

Fabos, B. (2004). *Wrong turn on the information superhighway: Education and the commercialization of the Internet*. New York, London: Teachers College Press.

Franklin, J. (2006). Protest paralyses Chile's education system. *The Guardian, Wednesday June 7*, 2006.

Gall, M., Gall, J., & Borg, W. (2006). *Educational research. An introduction* (8th ed.). Boston: Pearson Education.

García Huidobro, J. E., (Ed.). (1999). La reforma educacional chilena. Madrid, España: Popular.

Hepp, P. (1991). *Proyecto "Red Interescolar de Comunicaciones"* (unpublished report). Santiago: Ministry of Education.

Hinostroza, J. E., Labbé, C., & Claro, M. (2005). ICT in Chilean schools: Students' and teachers' access to and use of ICT. *Human Technology, 1*(2), 246–264.

Honey, M., McMillan, K., & Carrig, F. (1999). Perspectives on technology and education research: Lesson from the past and present. In *Paper presented at the 1999: Evaluating the effectiveness of technology, Washington, DC*.

Kerr, S. (1991). Lever and fulcrum: Educational technology in teachers' thought and practice. *Teachers College Record, 93*(1), 114–136.

Kozma, R. (2003). A review of the findings and their implications for practice and policy. In R. Kozma (Ed.), *Technology, innovation, and educational change: A global perspective*. Eugene, OR: International Society for Educational Technology.

Ministry of Education (1994a). *Informática educativa* (unpublished report). Temuco: Instituto de Informática Educativa.

Ministry of Education. (1994b). *Informática educativa: Principios y usos* (Monografía No. 4). Ministry of Education, Programa MECE.

Ministry of Education (2006). Matrícula de niños y jóvenes por dependencia y área geográfica. <http://w3app.mineduc.cl/Sire/index>.

Montgomery, K. (1996). Children in the digital age. *The American Prospect, 27*(July–August 1996).

Montgomery, K. (2000). Children's media culture in the new millennium: Mapping the digital landscape. *The Future of Children: Children and Computer Technology, 10*(2), 145–167.

Mutzig, Jean-Marc (2001). Programa Nacional de Informática en Educación PROINFO, documento presentado en el "Primer taller iberoamericano de políticas TIC en educación" (Santiago), Red Enlaces. <http://www.redenlaces.cl/documentos_tic.htm>.

Noblitt, J. (1997). Top-down meets bottom-up. *Educom Review, 32*(3), 38–43.

Norris, C., Soloway, E., & Sullivan, T. (2002). Examining 25 years of technology in US Education. *Communications of the ACM, 45*(8), 15–18.

OECD. (2004). *Reviews of national policies for education: Chile*. Paris: OECD Publications.

PNUD (2006). *Desarrollo humano en chile. Las nuevas tecnologías: cun salto al futuro*? Santiago: Programa de las naciones Unidas para el Desarrollo.

Postman, N. (1993). *Technopoly, the surrender of culture to technology*. New York: Vintage Books.

Postman, N. (1995). *The end of education: Redefining the value of school*. New York: Vintage Books.

Quivy, R., & van Capenhoudt, L. (1988). *Manuel de recherche en sciences sociales*. Paris: DUNOD.

Raczynski, D., & Muñoz, G. (2007). *Reforma educacional chilena: El difícil equilibrio entre la macro y la micropolítica* (unpublished report No. 31). Santiago: CIEPLAN.

Ramirez-Romero, J. L., & Galeana, N. (2006). The ICT in Latin America: Some experiences, problems and limitations. En Vladimir Uskov (Ed.). *Proceedings of the computers and advanced technology education, CATE 2006*, Lima, Perú, October 4–6, pp. 528–565.

Rasinen, A. (2003). An analysis of the technology education curriculum of six countries. *Journal of Technology Education, 15*(1), 31–47. Fall 2003.

Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing how and what children learn in school with computer-based technologies. *The Future of Children, 10*(2), 76–101.

Salinas, A., & Sánchez, J. (2006). PDAs and ubiquitous computing in the school. In *Human centered technology workshop*, Pori, Finland, Junio 11–13, pp. 249–258.

Salinas, A., & Sánchez, J. (2007). Digital inclusion in Chile: Internet in rural schools. In *World Conference on Educational Multimedia, Hypermedia & Telecommunications ED-MEDIA*, June 25–29, Vancouver, Canada, pp. 161–170.

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

Sánchez, J. (1991a). Major trends in the use of computers in Latin American schools. *Educational Technology, 31*(12), 56–58.

Sánchez, J. (1991b). Educational computing in Chile: Trends, issues, and recommendations. *Educational Technology, 32*(3), 54–56.

Sánchez, J., & Salinas, A. (2007). ICT & learning in Chilean schools: Lessons learned. In *CAL'07 conference, 'Development, Disruption and Debate'*, Ireland, 26–28 March, p. 56.

Sandholtz, J., & Reilly, B. (2004). Teachers, not technicians: Rethinking technical expectations for teachers. *Teachers College Record, 106*(3), 487–512.
Sandholtz, J., Ringstaff, C., & Dwyer, D. (1997). *Teaching with technology: Creating student centered classrooms*. New York: Teachers College Press.
Shields, M., & Behrman, R. (2000). Children and computer technology: Analysis and recommendations. *The Future of Children: Children and Computer Technology, 10*(2), 4–30.
SIMCE (2005). *Informe de resultados 4° básico* (unpublished report). Santiago: MINEDUC.
Slator, B. M. (2006). *Electric worlds in the classroom: Teaching and learning with role-based computer games*. New York: Teachers College Press.
Sprague, D. (2004). Technology and teacher education: Are we talking to ourselves. Contemporary issues in technology and teacher education [Online serial], 3(4). Retrieved 12.06.06. <http://www.citejournal.org/vol3/iss4/editorial/article1.cfm>.
Strauss, A., & Corbin, J. (1990). *Basics of qualitative research*. Newbury Park, CA: Sage.
Sunkel, G. (2006). *Las tecnologías de la información y la comunicación (TIC) en la educación en américa latina. Una exploración de indicadores*. Santiago: CEPAL.
Suppes, P. (1980). The future of computers in education. In R. Taylor (Ed.), *The computer in the school: Tutor, tool, tutee*. New York: Teachers College, Columbia University.
Taylor, S., & Bogdan, R. (1998). *Introduction to qualitative research methods*. New York, NY: John Wiley & Sons Inc.
TIMSS (2004). *Highlights from the trends in international mathematics and science study (TIMSS) 2003* (unpublished report). Washington, DC: US Department of Education.
UNESCO (2006). *Education counts. Benchmarking progress in 19 WEI countries*. Montreal: UNESCO.
United Nations (2005). United Nations conference on trade and development, The Digital Divide Report: ICT Diffusion Index. New York: United Nations.
Wartella, E., & Jennings, N. (2000). Children and computers: New technology-old concerns. *The Future of Children, Children and computer technology, 10*(2), 31–43.
Wenglinsky, H. (2005). *Using technology wisely: The keys to success in schools. The TEC series*. New York: Teachers College Press.
Zea, C., Atuesta, M., & González, M. (Eds.). (2000). *Conexiones. Informática y escuela, un enfoque global. Medellín*, Colombia: Fondo Editorial, Universidad Pontificia Bolivariana, Colombia.
Zucker, A. A., & Kozma, R. (2003). *The Virtual High School: Teaching generation V*. New York: Teachers College Press.