ICT for rural education

A developing country perspective

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Abstract: In 1991, as part of its educational reform, the Chilean government launched the Information and Communication Technologies (ICT) in Schools initiative, the “Enlaces Network”. Its aim is to properly integrate ICT into Chilean public schools. After more than ten years of development, with 100 percent of Chilean secondary schools and more than 50 percent of the primary schools already using ICT, Enlaces is entering a new phase with a more curriculum-oriented focus and with the goal of incorporating all rural schools by year 2005.

The paper addresses the main implementation constraints of the Chilean rural environment and their effect on the ongoing ICT policy: The geographical isolation and precarious infrastructure; the fact that rural schools are usually very small schools with different grades sharing the same classroom. The cultural reality of rural areas involves a special kind of relationship between the school and the local community. Those constraints, together with the previous experience with Enlaces in different Chilean realities, have been taken into account to define a special ICT policy for rural schools in Chile. First, a special long-term teacher training program with a specific pedagogical approach that fits a rural environment has been developed and tested in pilot schools. Second, the definition of a local support organisation to help sustain development strategies in the long run has been established. Third, the hardware and software infrastructure required and Internet access have also been analysed together with the technical support. Finally, community involvement in school activities was also included in the policy.

Key words: elementary education, conditions for learning, developing countries

1. THE CHILEAN EDUCATIONAL REFORM

Chile is a country with close to 15 million inhabitants with a UNDP Human Development Index of 38 among 160 countries and 16 percent of the population is rural.

Its educational system has close to 10 300 schools (9 000 primary and 1 300 secondary schools), 130 000 teachers and 3 100 000 students (2 300 000 in primary and 800 000 in secondary schools). The rural population data are shown in Table 1.

Table 1. Chilean rural schools

Characteristics of rural schools	Number of schools
One teacher school	2115 (65%)
Less than twenty students per school	1600 (49%)
Regular public transportation	706 (22%)
Schools with electricity	3027 (92%)
Schools with telephones	653 (20%)
Total number of rural schools	3280 (100%)

For the last twelve years, Chile has undergone major educational reform. A new curriculum for both primary and secondary education has been designed and gradually introduced in all school grades; new teaching and learning methodologies are being implemented in order to achieve a higher quality and more equity in our education; more resources, textbooks, infrastructure and better teacher salaries are all part of the comprehensive effort. The Information Technology initiative, the "Enlaces Network", is an important component of the reform and aims to determine the benefits, contents, costs and replicability of initiatives involving educational computing and networking in Chilean public schools. It incorporates mechanisms for evaluating impact and seeks to determine the roles of computer technology on schools with the fewest resources (Hepp 1999).

In 2001, after 10 years of implementation, Enlaces could show the following results: three million students (90 percent) using ICT in 6 300 Schools (5 000 primary and all 1 300 Secondary); 70 000 teachers trained; 75 percent of all schools with free Internet; ICT is an integral part of the new curriculum; teachers have access to a special plan to buy low cost computers; and total expenditure of Enlaces for the decade US\$110 Million.

Each school has received: Teacher training for three years together with technical support; equipment (38 000 computers together with printers, local area networks and furniture); a variety of productivity and educational software; free Internet access for most schools; and curriculum-oriented digital content on Internet. As a result, Chile has now 57 students/computer; 9/14 computers per primary/secondary school; and 10 teachers per computer.

In 2000, after completing its main goals, Enlaces began a new era and the rural schools became one of the highest priorities for the next six years. They were not included from the beginning because their poor infrastructure and weak communication facilities made it very difficult for Enlaces to train teachers and incorporate computers. After more than a decade of progress with the educational reform and improved conditions, Enlaces was ready to embrace rural education.

2. ICT FOR THE RURAL SCHOOLS

2.1 Institutional framework

Since its beginning, Enlaces has built a working relationship with close to 25 universities all over the country that contribute to the program with teacher training activities and materials, web-based content production, software evaluation, field research and healthy criticism. The universities are organized in five geographical zones for their work with Enlaces. The southern zone has the largest number of rural schools where piloting began a few years ago. The zone has 1 651 schools, about 50 percent of the total, with an average of 27 students and 1.6 teachers per school.

To improve the information exchange with the rural schools and also to promote the sharing of ideas and solutions among them, the Ministry of Education works on a monthly basis with groups of schools geographically close to one another organized in clusters of five to twelve schools per cluster. The clusters are called “microcenters” (San Miguel 1999; Wenger 1998). In the southern zone 1 651 schools have been grouped into 231 microcenters with an average of 7.1 schools per cluster.

Each university that works with Enlaces has the responsibility for a number of microcenters for a period of at least three years. Their work is closely coordinated with other professionals from the local Ministry of Education that attend the same schools and they normally organize together each visit to the microcenter meetings. Specially prepared teacher trainers attend each microcenter at least four times a year and visit a specific school another four times. Given the geographical situation of many of the schools, visits may last for a whole day and sometimes, during winter, even longer.

2.2 Rural Conditions and Opportunities

Chilean rural schools present a number of characteristics that are different from urban schools and call for a special ICT policy. The characteristics can be grouped in four categories: Location, infrastructure,

size and culture. Although they offer new challenges for an ICT policy, some of the schools represent a unique opportunity for change and innovation inside a classroom.

2.2.1 Infrastructure

Most rural schools are small buildings comprising a single classroom, an office for the teacher and space to store material. Most of them have now stable electricity or will soon have thanks to a national initiative for all rural communities.

When schools have dial-up phone lines with low bandwidth, e-mail is provided during low fare periods of time using store-and-forward protocols through an ad-hoc software product developed by Enlaces: “La Plaza” (Hepp, Alvarez, Hinostroza and Laval 1993) as shown in Figure 1.

Figure 1. La Plaza: a user-friendly interface for primary schools

Although rural schools now have relatively good structures, normally wood with isolated walls and roofs, the schools' environmental conditions may negatively affect hardware, especially in schools that are close to the sea with its sand, salt and humidity, or amidst a windy and dusty countryside. Roads are normally without asphalt, and in windy and dry days the levels of dust will pose a real threat to moving parts in all equipment.

Those conditions call for a training strategy that includes basic technical skills for preventive and basic hardware maintenance to cope with the most common problems that arise in the ICT infrastructure of the school. The

maintenance information has been gathered after many years of work with small schools, so Enlaces technical managers now provide a very specific set of problem-solving routines for all teachers and trainers.

When technical or economical conditions don't allow Internet access (Trucano and Hawkins 2002), the school receives a set of CD-ROMs with educational web sites that have been carefully selected and documented. The CD-ROMs are safe for students because of their selected content and students can use the software to communicate with other students as shown in Figure 2.

Figure 2. "Mapuche" e-mail written by an indigenous student using La Plaza

Such restricted Internet use allows rural students to have access to valuable content that is usually found on the Internet (such as literature, music, science, museums), but implies some restriction to the access of communication services and content based on online database access.

The Enlaces team is closely following new technical alternatives for rural communication (Trucano and Hawkins 2002; WorldLinks 2001) such as satellite connections but the alternatives require a high investment in infrastructure, making the service extremely expensive for a low number of access points. Use of a satellite segment still has a monthly cost of several thousand dollars but could be used to provide shared Internet access to thousands of schools. Each school would need an initial investment of less than US\$10 000, but costs are becoming more affordable. The monthly fare would be less than US\$50.

2.2.2 Location

Rural schools are normally located far from urban areas where technical assistance is more readily available. In many cases there is no local public transportation so teachers and students have to walk everyday from their houses to school, increasing transportation costs (e.g., delivery and maintenance of equipment and software, training activities and visits).

The long distances that are normally required to reach a rural school, restricted access in some places during the winter or particularly remote locations (i.e., schools in distant islands), require a teacher training and support strategy during concentrated periods of the year, another reason for the teachers to learn some basic hardware maintenance procedures. They should be capable of solving most hardware and software configuration problems by themselves. Achieving a relative autonomy from urban support centers is a goal of the training program.

2.2.3 Size

Most rural schools are located in areas with low population density so they are very small schools sharing the same classroom with different grades. The situation poses a number of challenges, but interestingly, it also offers new opportunities for outstanding learning situations using ICT.

One of the main challenges for teachers in rural schools is to provide a simultaneous pedagogical intervention with several grade levels in the same classroom. Small mixed-class schools offer a good opportunity for organizing the classroom in groups of similar learning levels. Also, conditions seem to offer a suitable opportunity for having the computer as a learning resource available for small-group collaborative work inside the classroom in a learning corner.

Collaborative-based learning (Campos, Cerda, Villarroel and Rivera 1998; Crook 1994) using ICT tools is one of the main strategies in rural environments. If Internet is available, the strategy may have the most profound effects in small and isolated schools where restricted conversation spaces around a few people do not offer the diversity of urban environments. With the Internet, collaborative projects may reach students from other schools in the same region and also students and teachers from all over the world, amplifying the quality of the conversational spaces and stimulating social interaction (Burniske and Monke 2001; Crook 1994; Githiora-Updike 2000). Chilean schools are stimulated to work on projects such as WorldLinks, I*EARN and Think.Com.

Small schools usually involve the challenge of a reduced number of teachers. In many cases, the lone teacher in a school might have a non-

professional initial formation and also lack a professional support network. In those cases it is important to provide a peer support network, especially when facing a highly demanding cultural challenge like the one represented by the introduction of ICT. Teacher training strategies may solve part of the problem if they foster the formation of teacher self-support networks amongst neighboring schools, for example grouping teachers in teacher training workshops.

2.2.4 Culture

Rural areas have more profound links with their surrounding community than urban schools. Rural communities normally have less technological resources and more restricted information sources, conditions that are normally perceived as negative by people from more urban education areas who feel social or professional isolation in rural settings. Therefore it is important to realize that ICT can have an impact on the community as well.

The Enlaces experience shows that parents will normally regard the introduction of computers and Internet in their schools as a positive modernization effort and will stimulate their children to take advantage of the new educational resources. Students who may never hope to have computers at home will be more motivated to attend schools, looking forward to have a chance to explore and “play” with new machines. In most cases, teachers will also have a very positive reaction, perceiving the new opportunities provided by the ICT as a professional upgrade that makes their conditions closer to those of their urban colleagues.

Rural teachers are used to working under severe conditions with very scarce resources. Out of necessity they are used to solving problems in the schools in creative ways. This positive attitude can be a very powerful change force for innovation in a rural learning environment (Fullan 2000; Hargreaves 1994). Teacher training initiatives take this attitude into consideration when it comes to the choice of software, content, as well as learning practices appropriate and relevant for this reality.

It is also a reality that some communities that have a strong cultural identity (i.e., ethnic groups) sometimes feel, at least initially, that technology should be resisted as a cultural “invasion” from the dominant groups. This is a potential risk that has to be recognised and dealt with carefully but it is also the case that the groups may come to value technology as a powerful means to better represent and preserve their own cultural identity.

3. TEACHER TRAINING PROGRAM

The Enlaces teacher training strategy is designed to address the special conditions of rural schools. Training is regarded as a process of cultural appropriation because the way technology is used in rural schools is distant from teachers' current cultural practices. The integration of technology is a progressive process, requiring initial external support to help the teacher to actually participate in practices that integrate technology for pedagogical aims. This is seen as a "scaffolding" process in which an external "facilitator" works with the teacher within her/his "zone of proximal development" (Crook 1991; Ertmer 2001; Vygotsky 1978).

As an example of the training program, the goals of the teachers' first year of training are as follows (Enlaces 2001):

- Identify and use ICT resources that could support curricular activities inside the classroom — usually a word processor, a spreadsheet, painting software and various educational software packages related to early literacy and arithmetic. The software should meet the teachers' preferences and their students' needs. Teachers should understand how to organize the resources for classroom uses and for maximum student participation.
- Select, adapt, design and perform from three to five educational activities where students may use ICT resources. Teachers will have a set of sample activities to start with but should later be capable of designing their own. Collaborative work is strongly promoted as a learning strategy and is also used during the training itself, i.e., with groups of teachers.

The core of the teacher training program lasts for three years and is organized around the following three strands:

1. Basic ICT Skills Workshops: During the first two years teachers from one or two microcenters meet together and attend four workshops (nine days in total). The workshops are designed for teachers to achieve the basic skills required to use the equipment, basic software (Office-style packages) and explore new educational software that they might receive in the future.
2. In-classroom sessions where, during the three years of core training, the facilitator goes to each classroom during monthly visits to schools. In each visit s/he and the teacher work together with students in the implementation of pedagogical activities supported by ICT.
3. Microcenter sessions when, after each visit to the school, the facilitator and all the teachers from the microcenter meet together in a regular microcenter meeting. In the meetings they reflect and design together in relation to the integration of ICT in their teaching.

During the initial three years of teacher training, schools also receive regular technical support visits. Technicians working for the universities solve basic configuration problems, help teachers diagnose hardware problems and support them with the warranty procedures as well as train them in basic technical procedures such as virus disinfecting, file backup, and other management functions. After the three year period, all schools will receive permanent basic support intended to keep the technological infrastructure working and keep a pedagogical link with university consultants.

Given the relative isolation of rural teachers, trainers must work to develop the highest possible levels of teachers' autonomy. A set of self-training materials are part of the learning toolkits. If e-mail is available, teachers belonging to a microcenter are strongly encouraged to communicate and construct a community of apprenticeship. To promote that attitude, during the monthly meeting with the trainers, teachers are encouraged to share their experiences, problems and solutions. Finally, between meetings, each teacher will have specific work to accomplish with students, and will have to present and discuss its outcome with the rest of the teachers in the next meeting.

The quality of teacher trainers is essential to the initiative. The trainers belong to a group of specially selected teachers who must have experience working with ICT in their own schools for at least one year and their background should also include previous experience as primary teachers, if possible experience in rural education. Each trainer works with an average of 15 rural schools and, due to his/her own permanent training needs, normally works full time as a teacher trainer in close relation with one of the universities related to Enlaces.

Trainers must participate in collaborative training sessions for themselves during their first year as trainers. Besides developing strong ICT skills and experience in their use, part of their training includes an understanding of the educational reform and of the Chilean rural socio-economic reality. They must also understand the different approaches to ICT in education, the various motivational skills that might work with teachers and develop the technical skills needed to keep the ICT infrastructure in a school up and running. If necessary, trainers must also acquire an understanding of the indigenous culture and learning traditions.

3.1 Community Involvement

Parents and other members of the community surrounding the school are invited to participate in ICT-related activities in the school. The activities are designed by the teachers who, with the help of the students, teach adults the

different uses of ICT. E-mail is specially appreciated but also Internet browsing so the community can read the news and learn about prices at the urban main shops.

The integration of parents has various positive side-effects for the school. First, by learning how to use computers, parents appreciate their possibilities and are more willing to support the school with time and small amounts of money for computer supplies, software or hardware purchases, upgrades and repairs. Second, by having a closer relationship with the school, parents become more interested and supportive of the school in general and therefore of their children's learning advances. Finally, the parents can use technology to expand their information sources and enhance their decision-making processes. Opening the parents to the rural schools that participate in Enlaces is regarded as a step forward toward bridging the digital divide.

4. CONCLUSIONS

Rural schools' special conditions (infrastructure, location, size, and local culture) pose a number of requirements and offer special opportunities for an educational ICT strategy. Teacher training should include a more thorough understanding of hardware and software issues to cope with maintenance and configuration problems that are normally dealt with by technicians in urban schools; teachers in small isolated schools with scarce resources normally have a positive attitude towards ICT for their own professional development. If Internet is available, it can be used as an important source of general news, educational tools and resources, and as a means of keeping in contact with other teachers.

Learning may be significantly enhanced when different grades share the same room by working collaboratively with ICT resources. If Internet access is available, students participate in world-wide projects such as I*Earn and WorldLinks, and will find content that is relevant for their personal interests, such as music, arts and sports. If Internet is not available, phone lines may allow for e-mail connections. Otherwise, CD-based content simulating a restricted Internet environment is used.

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BIOGRAPHIES

Pedro Hepp received his degree in engineering from the Pontificia Universidad Católica de Chile (1976) and has a Ph.D. in Computer Science from Edinburgh University (1983). He is head of “Enlaces” (1990–2001) and of the “Community Networks” project (2000-2002). A director of Instituto de Informática Educativa, Universidad de La Frontera, Chile (1996-2001) and a full professor at that university, he was an Associate Professor at the Computer Science Department, Pontificia Universidad Católica de Chile (1976-1992) and is now principal researcher of several FONDECYT (Conicyt, Chilean research funding agency) projects on software engineering, multimedia, expert systems and education.

Ernesto Laval is an engineer and has a M.Sc. degree from the Pontificia Universidad Católica de Chile. He is completing his Ph.D. at Bristol

University and presently works at the Instituto de Informática Educativa from Universidad de La Frontera in Temuco, Chile. Since 1991 he has been involved in the design and implementation of “Enlaces”. In 1999 he was appointed as the coordinator of the rural chapter of Enlaces, and he is currently working with the Ministry of Education in the design of the Chilean strategy for literacy and numeracy in primary education.