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Chile's Learning Network

by
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I. Preface

1. In today's schools, computers are used as much for communicating as they are for computing. Computer-mediated Communication (CMC) by telephone and satellite offers many exciting opportunities to both teachers and students to participate in learning networks. The use of computer networks in primary and secondary education, as well as higher and adult education introduces new options to transform the way teaching and learning takes place in schools. Use of these networks is generating enthusiasm among educators and students, who find that networking technologies improve upon traditional ways of teaching and learning and open new opportunities for communication, collaboration, and knowledge building. Indeed, the convenience and effectiveness of this new mode of learning make it a major educational force for the twenty-first century (Harasim, Linda et. al., 1995).

2. This study¹ focuses on a unique experiment which is taking place in Chile to establish an information and communications network among the nation's public primary and secondary schools. The network called Enlaces (Links), forms part of the Chilean government's major educational reform program (MECE), which aims to improve the quality, efficiency, and equity of primary and secondary education. Enlaces is the creation of Pedro Hepp, a computer engineer, formerly with the Faculty of Engineering at the Catholic University in Santiago. Established in 1993, as a pilot demonstration project in the southern part of the country, Enlaces has built a remarkable network among some 180 primary and 62 secondary schools, trained hundreds of teachers in its use, and is supplying educational software, some of which like "La Plaza" was developed in Chile. Most significantly, a majority of the schools in the pilot program are among the country's poorest communities, mainly indigenous population, and most lacking in educational resources. And most importantly, there is growing evidence that the computing and communications technology provided by Enlaces is contributing to the many exciting changes taking place in Chile's schools.

3. Having proven so successful in its pilot phase, Enlaces was recently converted into a national program by the Ministry of Education and provided the political and financial support to incorporate all secondary schools and half of all primary schools by the year 2000. The major challenge now facing Enlaces is achieving

these ambitious physical targets while also providing schools with the teacher training and technical support required to use their technology successfully. In this new national phase, Enlaces will also be challenged in having to work through and with some new partners: the universities and IBM. The nation's universities now form part of a technical assistance network established by the Ministry of Education to assist Enlaces in providing network schools with the necessary training and technical support. And IBM, having won a major bid to supply hardware and software to the network, joins the Apple Computer Corporation, which has provided most of the hardware and considerable technical assistance, in helping Enlaces expand its network in the years ahead.

4. **Purpose of Study.** The aim of this study is to examine the Enlaces project and the role of the educational network within the framework of Chile's overall educational reform agenda at the primary and secondary levels. It traces the growth and development of Enlaces from a small experimental pilot project to a national program. It analyzes the many dimensions of the project such as: its educational objectives and operating strategies, technology choices, training and technical support strategy, management and administration, costs and the role of the Apple Computer Corporation. The study also looks at the many challenges facing Enlaces in the coming years and draws some lessons from the Chilean experience which will be helpful to other countries in defining the role of the Internet in supporting education in the coming years.

5. This study will be of interest to educational policy makers and technicians in all countries contemplating the establishment or expansion of their own educational network. The Chilean experience

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is both encouraging and sobering. On the one hand, it shows what a relatively small middle-income developing country can accomplish if it has the political will, financial commitment and technical expertise. On the other, it reveals the need for carefully planning the introduction of technology in education and the benefits of starting with good pilot projects and then going to scale after gaining knowledge and experience. Most importantly, Chile is an example of how one country is attempting to modernize its education system by introducing computers, thereby positioning itself for the important role which knowledge-based economies will play in the years ahead. Assuming Enlaces will successfully meet the challenges ahead, and that educational reform proceeds achieve its human development goals, Chile will be well-positioned for economic growth and social development in the new information age in the 21st century.

II. Background

6. **Chile's Educational System.** Chile, with a population of close to 14 million, has a well developed education system which compares favorably to its neighbors and to higher income economies. Adult literacy is about 95% and the average years of schooling now attained by Chileans is some 10 years. Access to primary education is now essentially universal, secondary education is available to some 82% of the student population, and enrollments in higher education, while still relatively limited, are rapidly expanding. In the mid- 90s, total pre-university enrollment in Chile amounted to some 3 million students attending over 15,700 schools; close to 2 million were attending primary school, 653,000 attending secondary schools, and the rest in preschool education. Higher education enrollments reached some 285,00 students attending some 34 universities, 133 technological centers and 53 professional institutes.

7. Despite these impressive achievements, Chile's education system faces difficult problems in quality, efficiency and equity, especially in schools serving students in low-income urban and rural communities. Low standardized test scores in math, Spanish and other subjects reveal poor mastery of curriculum objectives by both primary and secondary school students. The primary and secondary levels are also characterized by high inefficiency reflected in late primary school entrance, high repetition rates, and high drop-out rates, especially in rural areas, where many schools do not offer full primary education. Secondary education also shows low external efficiency, failing to provide students with higher-order thinking and problem solving skills required by tertiary education institutions and the labor market. Lastly, urban and rural poverty and inequalities in the delivery and quality of educational services contribute to regional disparities in student participation rates and achievement levels. This also accounts for the fact that only five percent of those belonging to the lowest-income households continue onto tertiary education, compared to 45 percent of those be-

longing to higher-income households.

8. The shortcomings of the system are due to several factors. In primary and secondary education, there is a serious lack of skilled, well-trained and highly motivated teachers able to deliver quality education using modern pedagogical methods. At the secondary level, there is evidence to suggest that many teachers lack the necessary knowledge of the subject matter as well as lacking modern teaching practices. There are also serious shortages of educational materials, textbooks, teaching materials, teacher guides, school libraries, and computers. School infrastructure in many primary and secondary schools is inadequate in terms of space or facilities to carry out programs of study. Finally, there is a lack of effective educational supervision and monitoring by school principals and supervisors, essential to improve the quality of educational services.

9. The management and financing of education is a shared responsibility between the central government and municipalities. Under this arrangement, preschool, primary and secondary schools are today the responsibility of the country's 334 municipalities. The municipalities are completely autonomous in the administration of material, financial, and human resources, as well as the maintenance of schools. However, each municipalities received resources for education from the central government based on average monthly student attendance. The central government also encourages through a subsidy payment per student, private individuals and non-governmental organizations to create tuition-free schools.

10. Although the current management system has many positive features, the institutional capacity for managing education is generally weak at all levels. The Ministry has difficulties translating educational policies and strategies into concrete programmatic actions at the school level and has a weak and understaffed cadre of school supervisors. The weakness of the central government and the lack of planning and managerial skills in the municipalities means that primary and secondary schools operate with considerable autonomy.

11. **Education Reform.** In 1991, Chile launched an ambitious educational reform program which today includes both primary and secondary education. It began with a Primary Education Improvement Project (MECE), a \$243 million 5-year program to improve the quality, efficiency and equity of its primary system. Under the MECE program, Chile aimed to allocate grants to some 5,000 municipal schools to fund innovative multi-year quality improvement projects designed by the schools, to provide in-service training for some 78,000 teachers and 8,000 principals, distribute textbooks and complementary reading materials, to upgrade and expand school infrastructure, and to establish the Enlaces experimental network in some 100 mostly rural primary schools. MECE also aimed to strengthen the planning and administrative functions of the Minis-

try of Education and Municipal Education Departments by providing equipment and in-service training, creating an information system, and funding technical studies in education. In the first years of operation, MECE proved to be highly successful in achieving its objectives, giving encouragement to the Chilean government to proceed with the implementation of a comparable reform at the secondary level.

12. Chile's Secondary Education Quality Improvement Project (MECE-EM) was initiated on an experimental basis in 1994 in 124 secondary schools and became a full-scale national program in January 1995. The project aims to improve quality, equity and efficiency of secondary education by: reformulating the curriculum, for both the scientific-humanistic and technical-vocational schools, provide in-service teacher training to modernize pedagogy and enhancing the teaching and learning of higher order thinking and problem-solving skills, funding educational development projects (PDEs) prepared by the schools, and providing educational resources (textbooks, school libraries, teaching materials, infrastructure and computers. It also seeks to improve the external efficiency of secondary education by improving linkages between technical vocational secondary schools and the private sector in curriculum development, skill certification, in-service teacher training and the use of physical facilities. Lastly, building upon the sector management strengthening activities launched under MECE, it will seek to improve the leadership and management of principals and heads of school-curricular subject areas; establish and maintain a technical support network of universities and other entities which would provide technical assistance to participating secondary schools in training, development of learning materials and curricular needs.

13. **Enlaces Today.** Enlaces wisely began as an experimental pilot program. It was first launched in March 1993 with the goal of creating a telecommunication and computer network among 100 Chilean primary schools and associated institutions by 1997. Some 70% of the schools in the network were to be located in the southern region, 20% in the Santiago metropolitan area, and the rest in other regions. By end-1995, Enlaces had substantially surpassed that target, incorporating some 180 schools at both the primary and secondary levels.

14. In light of this success, the MECE set new objectives for En-

laces which are even more ambitious than the original ones. These goals are to have 50% of all primary schools and 100% of all secondary schools in the network by the year 2000. In addition, Enlaces plans to increase the number of computers given to schools joining the network, and supplement those already in the network. Table I summarizes the annual target for network expansion.

15. The plans for the next five years project a substantial increase in the number of new centers which will join the network, both at the primary and secondary level. In 1996, the projected increase is a little over two and one half times the level reached in 1995, which is ambitious, but feasible. However, in 1997 and 1998, the projected increases of sixteen and twenty-five percent respectively over current levels, will require some rethinking of Enlaces' current delivery system.

16. It is often said that Government leaders do not like pilot projects because they do not offer much in the way of political returns and are difficult to take to scale. However, the Chilean government has not been deterred by this thinking and has shown that a well-managed pilot project can be very useful to demonstrate the feasibility of establishing a large-scale project and to build important political support for its implementation.

17. As Enlaces moves from a pilot to a national program it will have strong political support owing to its successful pilot phase. President Frei showed the Government's commitment to Enlaces, when he personally inaugurated the national network at the end of 1995. Community support is also said to be strong, since parents believe that their children will gain important advantages in their education and employment from learning with computers in their schools. Sustained national and local government support are going to be crucial to the success of Enlaces, particularly in view of the project's substantial investment and annual recurrent costs.

18. **Goals and Expectations.** What are the Government's goals and expectations in investing in Enlaces? Are they realistic in view of the experience of other countries? Are the Government's goals and expectations being translated into operational activities? What is the Government's time frame?

Table I

Enlaces: Network Centers: Actual and Planned Growth as of November 1995

Year	Primary			Secondary			Totals
	Actual	Planned	Accum.	Actual	Planned	Accum.	
1995	118		118	62		62	180
1996		190	308		100	162	470
1997		609	917		293	455	1372
1998		1,229	2,146		397	852	2,933
1999		1,229	3,375		381	1,215	4,590

19. Enlaces has issued several documents which refer to its specific goals and expectations.² These goals and expectations have been evolving in light of experience during the pilot phase. There are two broad sets of expectations from information and communications technology: educational and social and economic. With respect to education, Enlaces' main goals are to provide teachers and students access to new and improved instructional content and methods, increased information resources for research and analysis, and improved communication for collaboration and dissemination of ideas. It further expects that Chilean schools will receive the following benefits:

— **Equity and decentralization.** Members of an educational establishment would become part of a school community regardless of their location in the country. Teachers in the network would have access to the same information and projects regardless of where they are located.

— **Pedagogical modernization.** The network would enable teachers and students to gain access to high quality educational software for instructional purposes. It would also modify teaching practice, knowledge transmission and acquisition, and stimulate student skill development

— **Modernization of education administration.** Teachers in the network would be able use their computer to produce instructional materials and to make educational administration more modern and efficient by maintaining data bases of student records, attendance and examinations

— **Teaching resource.** The network would facilitate the development of collaborative projects between the students and teachers in one school and those of another school. In particular, computers are expected to help develop collaboration and solidarity among teachers and students, introduce a new dynamism in the classroom, and a new expanded vision of the world outside. From a curriculum perspective, the network would produce a gradual integration of course content across the curriculum.

— **Professionalization** Teachers can share experiences, teachers guides, and successful educational experiences across the network.

20. Enlaces also projected important social and economic benefits which the country could expect to obtain through the introduction of information and communications technology in schools. By having access to computer technology in school, youth will later become change agents in introducing computer use in the productive and service sectors. Youth will also benefit from the higher level thinking skills stimulated by computers, and these skills are vital to the modern world: the ability to develop research strategies and selection criteria; skills for processing information, organizing and

planning activities, and the capacity to communicate effectively and coherently, presenting written ideas with autonomy and creativity. Finally, in having the possibility of world-wide communications during their school years, students will develop a world vision and the skills to communicate effectively in international relations.

21. Enlaces' goals and expectations are highly ambitious, yet generally well-conceived and very worth while pursuing. Monitoring and evaluations studies carried out during the pilot phase, which are discussed later in this study, indicate that Enlaces has been making good progress at the school level in achieving some of its goals. It has been able to do so, by absorbing some of the lessons learned from the United States and other countries during the 1980s and adapting them to Chile's own situation. There are four main lessons from experience which appear to be guiding the Chilean experiment:

a) Information and communications technologies are not ends in themselves, but the means to help improve teaching and learning in all subjects. When used effectively computers can be powerful tools, but they require changes in teaching methods, the fostering of group work, and developing new ways of communicating,

b) If information and communications technologies are to be accepted and used effectively in schools, they must be simple, user-friendly, and reliable; if they fail to operate, there needs to be a system in place within the school or outside to repair them

c) Schools should be given the autonomy to define for themselves, ways of using computers which are supportive of their educational activities. This process builds ownership and commitment to change. Dictates from above are generally counterproductive.

d) The introduction of technology in schools needs to be accompanied by initial and continuous teacher training and orientation to build confidence, skill and the desire to introduce innovations in teaching and learning.

22. **Telecommunications Infrastructure and Internet Network** Chile's telecommunication infrastructure is one of the more advanced in Latin America. Heavy public and private investments in the sector in the past couple of decades has given the country a backbone of copper and fiber optic cables. Since 1991, Chile has had Internet connections which cover a large portion of the coun-

² These statements can be found in: Enlaces. (Diciembre, 1994) *Ó Informatica Educativa Principios y Usos, Ó Monografía No 4 Enlaces. (Enero, 1995) Enlaces- Basica Estado de Avance Fundamentos Ó. World Wide Web site: <http://enlaces.ufro.cl>.*

try, and today it has five separate international connections provided by five companies. Two companies Reuna and RDC, the oldest Internet service providers, are providing national Internet links. Reuna is different from the other companies in that it is a consortium of state universities which have joined together to establish an extensive digital backbone, which offers speeds of 64 Kbps; Reuna's international connection is 1.5 Mbps,

23. The Enlaces network links primary and secondary schools and other educational institutions by means of Chile's national computer network. The linkages are made through seven centers located in five zones through out the country. Each center has the required equipment to service the schools in their zones and use TCP/IP Internet protocols for communications. The majority of communications among schools and institutions is carried out using conventional telephone lines and UUCP (Unix to Unix copy) protocols. Those schools which are part of the Enlaces network are able to communicate with each other using E-Mail and Bulletin Boards with standard addresses of the Internet. Electronic mail messages can be sent to and received from abroad with out additional costs to the school by using Chile's university networks as gateways to the Internet.

24. At present all schools in the Enlaces network have the equipment to be linked to the Internet, but do not have direct lines or service providers and their connection only permits them to receive text, but not graphics or sound. However, this situation is changing fast. Enlaces has launched an experiment with the Compania de Telefonos de Chile to connect schools directly to the Internet via fiber optic cables. Twelve schools in the Temuco area have already been connected and others are to follow soon. The cost of connections and service will be borne by the company free of charge for a year during which time, it will determine a rate structure.³

25. Most schools use telephone lines for network communications. However, some 3,000 or 36 percent of Chile's 8,250 public and subsidized primary schools are in remote areas such as in the southern part of the country do not have telephone service. In order to provide network access to these schools, Enlaces has begun experimenting with the use of radio. Using packet radios, Ultra High Frequency channels, and the TCP/IP protocol, Enlaces linked up four schools within a 20 kilometers radius, located in areas with out major geographic obstructions, on the Internet node at the Universidad de la Frontera in Temuco. Enlaces plans to continue experimenting with other communications technologies in 1996 while increasing the current number of nodes served by packet radios to 20. Meanwhile, Enlaces' engineering team has learned some important lessons: teachers in these remote schools can be taught to use the equipment and to help monitor its use, packet radios are reliable for transmitting electronic mail, and that this technology can only be used effectively where there are no geographic obstructions.

26. **Strategy.** Enlaces has used a gradualist demand-oriented strategy for expanding the network at the primary level which is similar to that used by EMCEE in providing other instructional materials and equipment to schools. Enlaces' staff have actively promoted the network by visiting schools and meeting with principals and teachers to brief them on the network's educational benefits. However, if and when schools wished to become part of the network, they had to demonstrate their commitment by applying officially, presenting a proposal as to how they intend to use the computer network in their educational programs, and agreeing to provide facilities, furniture and security for the computer equipment as well as to cover all recurrent operating and maintenance costs such as telephone, diskettes, paper, printer ribbons, toner and other items.

27. The strategy for expanding the network in secondary schools is different from that for primary. Instead of following a gradualist demand-oriented strategy, Enlaces plans to incorporate all 1,700 public and government-assisted private schools into the network by the year 2000. In order to reach this target, EMCEE will annually allocate to each regional secretary of education funding to enable a certain number of secondary schools to join the network. The regional secretaries would have the responsibility for annually selecting those schools, also based on the submission of project proposals, following selection criteria provided by Enlaces. The criteria would be similar to those already used by the program. Enlaces began its secondary school network program by incorporating 62 schools in 1995. While that in itself was a significant achievement, Enlaces will now have to increase its annual installations by 6 times the current rate⁴ if it is to incorporate all secondary schools by 2000. This is well within reach, as the government's contracts with Apple and IBM, include not only the purchase of computers and other hardware but also their installation.

28. **Provision and Access to Computer Equipment.** Primary schools accepted into the network have been provided computer equipment, software, furniture, and teacher training by Enlaces. The number of computers allocated to each school is determined by enrollments. The Enlaces standard formula is as follows: a small school (100 students or less) would receive three computers, a modem, a CD-ROM player, a dot-matrix printer, and software packages; a medium-sized school (100 to less than 300 students) would be entitled to six computers and the same quantity of peripherals (e.g. modem, CD-ROM, etc.) as the small school; and a large school

³ Enlaces is already using the Web to disseminate information about its activities in Chile and through out the world. Its Web site: <http://enlaces.unfro.cl> also provides information about networks in other Latin American countries and offers links to some of the well-known data banks and network sites in education.

⁴ This conclusion is based on the fact that Enlaces has 5 years to reach 1,700 schools, and currently has reached 120. At a minimum, it would need to increase installations to 370 per year, compared to some 60 per year during the first two years.

(more than 300 students) 9 computers and two CD-ROM players, and the same quantity of other peripherals allocated to small and medium size schools. One of the computers in each school also functions as a server but is also used like the other computers, both by teachers and students. The computers in each school are linked to a local network by a telephone line connected to a modem. One computer functions as the server to send and receive mail from the center in their zone. School computers are Apple Macintosh and PC compatible with 10BaseT ethernet cards. For internal communication schools use Macintosh system 7 or Workgroup for Windows 95, depending upon the platform.

29. Secondary schools, in contrast, are each being provided equipment for a multimedia room consisting of 11 computers, a network server, three printers, multimedia accessories such as CD-ROM's, and a wide range of educational software and productivity tools. Planning assumptions are that multimedia rooms would accommodate about 20 students. Those computers already in the schools would also be incorporated into the network, wherever possible.

30. What do these ratios tell about student access to computers? Table II provides some insights to access, by showing what the average maximum weekly computer access would be for each student in different size schools, based on certain assumptions. It was constructed following Enlaces' norms for the provision of computers to different size schools and it assumes that the equipment would be used through out the school day.

31. Table II shows that the maximum amount of time that each student could have on a computer working alone would be close to one hour in the smaller schools and only a half hour in the larger ones. However, since usually two to three students work on one computer together, the average per student time working with the computer could be as much as 90 minutes in the large schools and almost three hours in the smaller ones. In fact, schools have adopted different strategies for using computers. Some are limiting access to only students in certain grade on the basis of motivation, interest and other criteria. Others giving all children some access to com-

Table II

Average Maximum Weekly Computer Access by School Size (minutes per student)				
Computers	50/100 Students	100/300 Students	600 Students	1000 Students
3	108/54min.	-		
6		54/36min.		
9			27min.	
11				33min.

puters, even if it is only about 25 to 30 minutes a week. Still others, particularly secondary schools, might have other computers so that access is greater than suggested by the table.

32. Assuming that schools are placing two to three students on a computer and/or limiting access, many students might be getting at least one hour per week and perhaps even more time on computers. If so, the question is how to make the best use of this time? What can students do with computers in an hour per week? To its credit, Enlaces has not tried to dictate an answer to this question. It takes the view that it is up to each school to define their use of computers and to work out a schedule to make it happen. As a result, there appears to be considerable diversity and on-going experimentation in the use of computers in network schools as well as interest on the part of teachers in learning new applications.

33. **Software.** Despite the limited amount of educational software available in Spanish, Enlaces has been able to provide all of its network primary schools, a good basic collection of software. This software consists of titles produced in Chile for educational use and other titles produced in the United States and commercially available in Spanish. One of the most exciting pieces of software used in Chile today is La Plaza, which was produced first by Pedro Hepp and his colleagues and has been elaborated upon many times since La Plaza is freeware, distributed to schools by Enlaces, and is exemplary for its elegance, simplicity, and easy of use. It is also culturally, 100% Chilean, although its features can be readily used or adapted to all Latin American countries which have plazas.

34. **La Plaza.** La Plaza (the square) is a software program written in C++ which has a friendly-looking and colorful point and click interface that permits students and teachers to have easy access to several applications. Originally designed for the Macintosh, it is now also available for use with Windows 3.11 and PC compatible platforms. The interface, which is presented in Figure 1 below, shows four buildings which are familiar sites in most Chilean towns and villages: a Post Office, a Kiosk, a Museum and a Cultural Center.

Clicking the "Correo" or Post Office provides access to E-Mail, the newspaper stand stores electronic newspapers and other documents produced and downloaded by teachers and students, the "Museo" or Museum serves as an information center and interface for easy access to software. Enlaces has also bought site licenses for some 30 different software titles and has distributed different titles to small groups of schools. It is also providing schools an additional 10 multimedia educational applications developed in Chile. Finally, the "Centro Cultural" Cultural Center serves as a simple to use bulletin board system.

35. **Training and Technical Assistance Strategy.** School administrators and teachers are the keys to the effective introduction and

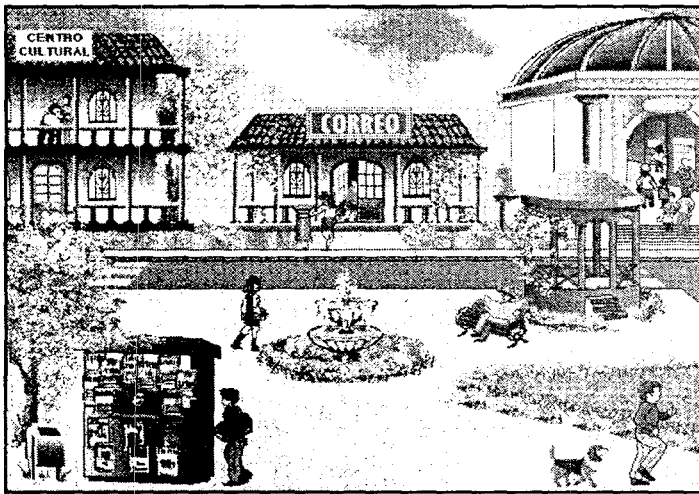


Figure 1

use of technology in schools. Where administrators and teachers actively support the use of technology, and are willing to attend training courses and experiment with the technology in their teaching programs, there is a very good chance that the school will achieve significant educational benefits. In Chile, as in most other countries, primary school teachers have generally greeted the introduction of technology into their schools with a combination of enthusiasm and trepidation. Their enthusiasm usually stems from the sense that computers will bring their school into today's world of information and communication and enable them to prepare their students for the future. Their trepidation is due to the fact that most teachers, not having grown up with computers, are fearful of the technology and have profound doubts that they will learn to use it effectively. While the majority of teachers are generally willing to try to overcome their fears and learn to use technology effectively, there are some who are unwilling or unable to change.

36. The training strategy adopted by Enlaces has been based on the view that there is not one solution that fits all schools and that training needs to equip teachers to find their own solutions. It has also attempted to train as many teachers as possible in each school to enable them to use computers in their teaching and avoid repeating the experience of the past ten years when only one "expert" laboratory instructor reigned supreme among the rest of the teachers. Lessons from the Apple Computer Corporation's Apple Classrooms of Tomorrow (ACOT) experience such as the value of training two coordinators in each school to work as a team and the benefits of involving teachers in hands on computer training in the classroom are also guiding Enlaces' training strategy.

37. Enlaces has provided in-service training to school administrators and teachers in each and every school which joined the network. During the pilot phase it managed to train several hundred administrators and teachers in schools in the southern districts. Most training was organized and conducted by the Enlaces staff in

Temuco with the help of consultants. However training was also carried out by university collaborators in Santiago. Enlaces has provided training in two phases. "Initial training," obligatory for all schools joining the network, has been held in situ, soon after a school has its computers installed. This training has consisted of six two-hour sessions weekly focusing on helping teachers to overcome their fears of the technology and to develop basic computer skills. It also introduced teachers to the various features of La Plaza emphasizing communications by E-Mail, conducting collaborative projects with other schools, and drawing upon the tools available through the Museum in La Plaza. The second phase of voluntary training consists of specialized month-long modular courses for about eight hours each devoted to learning about software applications such as word processing, spread sheets, and other productivity tools, KidPix, and their use in teaching.

38. Enlaces has also trained two teacher coordinators in each school to be leaders in the incorporation of technology in their schools. In training two coordinators, rather than one, Enlaces has enabled each to support the other in carrying on their roles and responsibilities. The coordinators' roles and responsibilities are to provide technical, administrative and general support to other teachers and the school director. They work with the school director in scheduling the use of computers, securing the necessary inputs and support for projects and undertaking other in-school activities involving computers. Another key role of the coordinators is to encourage innovation in teaching with computers and to promote the incorporation of computers into the curriculum. The training sessions for coordinators have often been used as well to help schools reformulate their original projects on using computers to make them more effective.

39. **Technical Assistance Network.** In the first three years, while the network was getting off the ground, Enlaces staff were able to provide all technical assistance directly to the network schools. However, now that it is to become a truly national network, Enlaces has adopted a new technical assistance network which should enable it to more efficiently service educational institutions throughout the country. The new network, which became operational in 1996, covers the length of the country and consists of seven zonal centers each located in one of four large zones; the heavily populated central zone covering Santiago and Valparaiso, has four zonal centers by itself. Each Zonal Center is located in a Chilean university which, under contract from the Ministry of Education, will provide a range of technical assistance and support services to the network schools in their zones. In some instances, a zonal center might sub-contract other entities in the zone to help it provide the required services and technical support.

40. Each Zonal Center has a detailed work plan for 1996-1997 during which they will provide two years of training and support to all primary and secondary schools joining the network. The work

plans for each Zonal Center are essentially the same and consist of four main foci: a) continuous teacher training, b) monitoring of attitudes and behavior of teachers employing computers in their work c) helping teachers achieve self-sufficiency in using computers, and, d) stimulating educational innovation. By the end of two years, each school joining the network would be expected to have reached a stage of independence and autonomy in using computers and maintaining them. To determine whether schools have achieved this stage of maturity, Enlaces has developed a series of detailed indicators of attitudes, teaching practice, and skill development. These indicators will prove very handy in assessing the qualitative outputs of the technical assistance network.

41. The 1996-1997 technical assistance plans are comprehensive and detailed documents, providing a clear set of objectives, training and support activities, and timetables for implementation.⁵ In the first year, the plan calls for the university to: a) assist schools in preparing their computer education projects (PIE) b) help local officials in selecting schools to join the network c) ensure that these schools have fulfilled the infrastructural and other requirements for received the computer equipment d) provide "initial" and follow-up specialized training of teachers and coordinators, and e) offer training to a new group of teachers not directly involved in a school's project for using computers. In the second year, the plan is to: a) help schools formulate and implement a new or extended PIE, b) train teachers and administrators to use computers to carry out routine administrative tasks, c) provide more in-depth and specialized training, particularly in the use of telecommunications in teaching: planning and executing collaborative projects with other schools and participating in national and international telecommunications projects using E-Mail. The plans also include training in using software, and especially CD-ROMs and providing teachers articles and other information on constructivist teaching methods and using telecommunications in their pedagogy.

42. **Monitoring and Evaluation.** Very few programs systematically monitor and evaluate their operations. It is, therefore, to Enlaces' credit that it has been regularly monitoring the operations of the network and supporting evaluation studies of the role and impact of computers on teaching and learning. La Plaza has a monitoring system that electronically logs network traffic and component use at each node. Its monitoring focuses on the use of the network, the attitudes and perceptions of users, and the changes which occur in the users as a result of network use. The Enlaces team has a full-time researcher in-charge of monitoring and evaluation who has been analyzing data obtained through the

43. What changes might one expect to see occurring in the teaching and learning taking places in Chilean schools as a consequence of the network?⁶ What kind of evaluations is Enlaces undertaking. According to Maria Ines Alvares, (Undated), Enlaces is contemplating seven different evaluations:

- "The impact of computer introduction in terms of achievement of the main objectives of the curriculum. We will use the national evaluation system already existing to measure changes in academic variables."
- Psychological variables of the students expected to change with this way of introducing computers at school. The variables considered are: creativity (fluency, flexibility, and originality of the products), perception about the school and perceptions about the teachers, cognitive development levels, social relationships and academic self-concept.
- Changes in teachers in the following variables: leadership, self-esteem, achievement motivation and perceptions about the school, the students and their parents, and personal disposition toward change and innovation.
- Changes in parents and guardians in the following aspects: perceptions about the school, perception about the teachers, and perception and commitment to their children's scholastic experiences.
- Traffic levels and software uses over the time and related to the variables mentioned above. We are also going to evaluate the relation of traffic levels to the growing levels of the network (numbers of schools and other institutions involved)
- Communication relationships with an adapted sociogramme, where the unit of analysis is every school of a town. This kind of analysis can show either leader schools or isolated ones. It can also show the directions of the communications of a sub-network constituted by a town and the relations among sub-networks.

⁵ The Plan de asistencia technical 1996-1997 Centro Zonal Sur Austral, which will be implemented by the Universidad de La Frontera was analyzed for this study.

⁶ According to a recent survey of 240 United States teachers and learners on the Internet, 70 percent noted that their experience in using networks had changed how they viewed education (Harasim and Yung 1993, cited in Harasim, 1995). Of 176 respondents to the question on whether computer-mediated communication is different from the traditional classroom, 90 percent responded yes and noted that: "The role of the teacher changes to that of facilitator and mentor. Students become active participants. Discussions become more detailed and deeper. Access to resources is expanded significantly. Learners become more independent. Access to teachers becomes equal and direct. Interactions among teachers are increased significantly. Education becomes learner centered; learning becomes self-paced. Learning opportunities for all students are more equal; learner-learner. group interactions are significantly increased. Teaching and learning is collaborative. There is more time to reflect on ideas; students can explore on the networks; exchange of ideas and thoughts is expanded; the classroom becomes global. The teacher-learner hierarchy is broken down. Teachers become learners, and learners become teachers."

- Telecommunication project generation inside the schools, level of project participation and level of software use for academic or professional purposes.”

44 Enlaces's monitoring system provides interesting data on network usage patterns over the past two and one half years. For example, the data shows that total network traffic, measured in terms of monthly messages, increased from 141 in April 1993 to 5,035 in November 1995. It also reveals changes in the pattern of message flows among schools. Whereas initially schools would only exchange e-mail with a limited number of neighboring schools, over time, they began to extend their contacts into other districts as well as to the outside world. Some 35% of all messages are sent outside Chile. The monitoring data also enables us to determine whether E-Mail traffic within the Enlaces network grew in absolute terms, or proportionately to the number of centers which have joined the network. As Table III below reveals, the average monthly total of messages per school during the period 1993-95 varied only slightly: In 1993 the average monthly messages per school were 38, in 1994 they increased to 54 and in 1995 they dropped to 47.

45. Enlaces has also conducted some evaluation studies to assess changes occurring in schools. In a recent paper, Enlaces researchers reported on some interim findings from their monitoring and evaluation activities.⁷ In order to measure these changes, they selected from 40 schools in the network at that time, a sample of some 350 teachers, 3000 students and 1,500 parents or guardians, according to several variables such as: educational level, geographical distribution, and population density. The study reported increases in creativity among 28% of the students, significant indications of changes in flexibility, originality and other thinking skills among 35% of the students, and some significant increases in cognitive development among 75% of students.

46. Other research by Enlaces shows positive changes in teachers' attitudes towards teaching, computers, and in the benefits of the network in their teaching. They also reported on positive changes in student attitudes and a significant increase in creativity. A survey carried out in December 1994 of some 70 teachers in network schools in Temuco showed that teachers were generally highly satisfied with the network and the benefits which they and their students received.

47. More recently a UNESCO consultant carried out interviews and observations in nine network schools to assess the contribution of the network towards progress in achieving the goals of Education for All. (Nunez, 1995). He reports that school directors, teachers and students spoke highly favorably about the network and claimed many benefits such as: reductions in school dropouts, improvements in achievement among slow learners, hyperactive and disruptive students, and excitement about being able to communicate with other schools. School directors and teachers felt positive

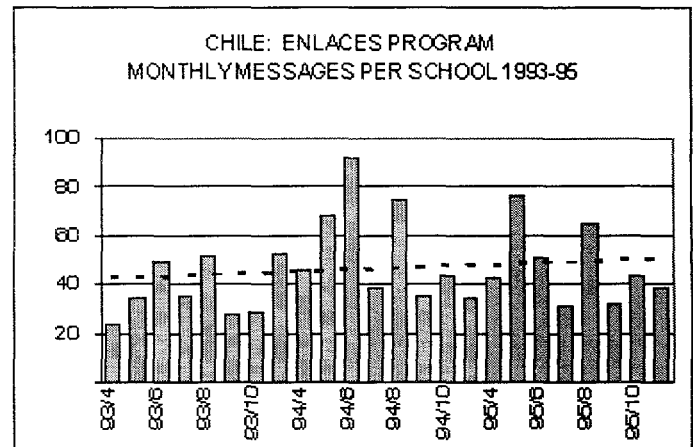


Table III

about their schools being able to have the same resources available to schools in higher income communities. They also reported on a wide variety of improvements in student communication skills, creativity, and self learning. Observations and interviews also revealed, not surprisingly, that students were learning to use computers faster than their teachers, that the relationships and communications between students and teachers were changing and becoming more collaborative, and that some teachers, having difficulty with the technology were resisting using it.

48. The World Bank and SRI International are jointly coordinating a research project comparing the experiences of Chile and Costa Rica in introducing computers in primary schools.⁸ The field research is being carried out during 1996 by teams in both countries. The research will examine the experiences of a small sample of schools in the Enlaces project and in the Omar Dengo Foundation-funded Computers in Education Program. The aim of the research is to identify the factors which contribute to the successful introduction of technology in schools. The research hypotheses are being drawn from experiences in other countries and focus on factors such as: the use of participatory approaches, the role of school management, the nature of professional development, and Government's political and financial support. The research is being funded by a small research grant from the World Bank's Research Support Budget.

49. **Organization and Management.** What are the management and administrative arrangements for Enlaces? How many people does it take to run a program of its size efficiently? Forming part of MECE, the Director of the Enlaces project reports to the Head of MECE and regularly consults with him on policy and strategic is-

⁷ See "Ripoll, Miguel, Moenne, Gerardo y Rehbein, Lucio. (1995) Proceso de Evaluación de usuarios: Red Enlaces-Chile" (Unpublished)

⁸ The Coordinators of this research are Michael Potashnik (The World Bank) and Barbara Means (SRI International).

sues effecting the network. Owing in large measure to the management style of Christian Cox, the Head of MECE, but also due to the confidence he has in Enlaces' Director, Pedro Hepp, Cristian Cox has given Enlaces great autonomy in managing its program activities. Of course, the Director enjoys a great deal of autonomy also being located in the southern part of the country!

50. Actually, from the beginning, Enlaces has operated out of two centers, one located in the Department of Computer Sciences at the Pontificia Universidad Catolica de Chile (PUC) in Santiago, the other on the campus of the Universidad de la Frontera (UFRO) in Temuco, some—miles from Santiago. The headquarters of Enlaces are located at UFRO, the result of the university having won a government tender to manage the network for a four year period beginning in March, 1993. Enlaces' offices are located in a modern 600 m2. facility on the university campus, constructed by the university.

51. Partly due to good management, and partly because of its arrangements with the Ministry of Education, Enlaces has kept a fairly lean structure and a minimum staff to carry out its work. Enlaces currently has an interdisciplinary team of some 40 professionals and support staff consisting of telecommunications engineers, psychologists, software designers, teachers, graphic designers, and journalists. Its administrative, financial and legal affairs and procurement activities are all handled by staff in the Ministry of Education.

52. **Financial Analysis.** Enlaces is funded primarily by the Chilean government, although, municipal governments and the school community also contribute substantial sums towards both investment and recurrent costs. The central government has funded the project from its own public investment budget and well as from loans from the World Bank. Chile plans to spend \$80 million on the program over the next five years. Of this total, the Government will contribute \$60 million and the World Bank, \$20 million. Rough calculations indicate that about 75% of the total allocation will be spent on equipment and 25% on training and technical support. The Government has earmarked all the funding required to achieve the targets for secondary education, but has currently only half the funding earmarked for its primary education targets.

53. How much does Enlaces cost per student? How does this amount compare to current educational expenditures per student? How do the costs incurred by Enlaces compare with other computer projects in other countries? These questions are difficult to answer with any great precision because Enlaces has not collected cost data on its on several key cost items essential for this kind of cost analysis. However, utilizing data provided by Enlaces, and rough estimates of other costs (e.g. facilities, furniture, personnel and maintenance), an attempt has been made to calculate the investment and recurrent cost structure of the project. It should be emphasized that these numbers are tentative, due to the lack of

hard data on all project costs. Since Enlaces recently began to collect cost data systematically, there will be more precise cost data in the future with which to up-date this cost analysis.

54. The cost analysis of the Enlaces project was done using standard cost analysis methods. Since the project operates in different size schools the analysis was done for three school sizes: small (200 students), medium (600 students) and large (1,000 students). The cost tables for each size school are shown in Annex I, tables 1, 2, and 3. As will be seen from these tables, the total investment and recurrent costs range from US\$5,880 for a small school to US\$20,932 for a large school. Like most projects of this kind, the costs of facilities and equipment: renovations and furniture, computers and related hardware and software roughly average about 60% of total annualized costs. The remaining costs: training, personnel, supplies, maintenance, and telephone roughly run about 40%.

55. The analysis shows significant variations in the percentage of investment and recurrent costs by school size. While in a small school, investment costs are 79% of total costs and recurrent costs 21%, in large school they are 61% and 39% respectively. These variations are mainly due to the different assumptions which were made about the staffing and other requirements of different size schools. Since small schools have few computers, they do not need to assign coordinators exclusively to the management of computers. However, large schools which have computer labs and a significant number of computers would need to a full time lab coordinator. Where full time lab coordinators are required to run computer projects, their salary costs raise the amount of recurrent expenditures considerably.

56. The Enlaces project appears to be relatively inexpensive when viewed on a per student basis, and especially with regard to recurrent expenditures.⁹ For a small primary school with 75 students, total project costs average US\$78 per student annually, but of this amount, only US\$17 is for recurrent expenditures. This amount is roughly equivalent to about 8% of the annual per-student recurrent expenditures (US\$213). Total per student costs are somewhat higher for middle size and large schools. Project costs for a primary school with 200 students are US\$56 per student annually but recurrent costs are about the same as for the smaller school US\$ 16 and 8% of annual per student costs. Annual per student costs drop considerably in large schools to US\$21 per student and 4% of recurrent expenditures.¹⁰

57. The low recurrent costs are due to two major factors. The first and most important reason is that the ratio of computers to students

⁹ This is in contrast to the finding in a recent article (Potashnik and Adkins, 1996) analyzing the costs of computer projects in education in a Latin American countries. One of the conclusions of the articles was that computer projects are generally expensive educational inputs which can cost on a per student basis, 50% or more of what countries are currently spending per student on all education inputs.

is low in most schools. In the small schools the ratio is about 1:33 while in the large schools the it drops to 1:91. As previously noted, these ratios are far from ideal for meaningful instruction and require each school to adopt strategies to ensure that some of their students have a reasonable amount of access. Second, it is likely that some of the recurrent costs used in the financial analysis may be under-estimated. Comparing Enlaces' recurrent costs to another computer project in Chile known as Genesis, shows significant differences. For example, where Enlaces' recurrent costs range from 21% in a small school and 39% in a large schools, they are 46% in a 400 student school in the Genesis project.

58. The Chilean government has followed some strategies for reducing costs and increasing benefits which have been noted elsewhere (Potashnik and Adkins, 1996). For example, Enlaces has taken great care in developing hardware specifications. They have tried to get the best and latest hardware available, but have been "cost-conscious" in choosing low-end solutions. Secondly, the Government has followed effective procurement practices thereby gaining substantial cost reductions and service benefits through international competitive bidding. Third, Enlaces is making major investments in staff development and teacher training which will lead to the effective deployment of computers in schools.

59. Enlaces is planning to follow a co-financing strategy under which the Ministry of Education would provide technical support, training and educational software for new network members, and local collaborators would fund the hardware, the physical space, consumables and maintenance. The strategy would be implemented in close collaboration with local educational officials to ensure balance and equity in dealing with the poorer communities. This strategy would enable the central government to reach its goals more quickly provided local communities were behind the program and able to mobilize tangible support for its implementation. It is also the best strategy for sustaining the program since the central government is not going to be inclined, under the current financing arrangements to continue to cover costs which ultimately are considered a local responsibility.

60. **The Role of Apple Computer Corporation.** The Apple Computer Corporation has played a key role in the growth and development of Enlaces. While Chile's technicians had their own well-defined technical solutions for the network, they regularly consulted Apple's Chilean distributor, AXIS, and Apple technicians in Cupertino for advice and ideas. On several occasions, Enlaces technicians visited Cupertino to discuss technical issues and to learn about new solutions being developed for networking, software design, and the use of computers in the classroom. Apple shared with the Chileans the rich experience of The Apple Classroom of Tomorrow (ACOT) and donated computer equipment and software to Enlaces for evaluation purposes. Most significantly, in 1995 Apple's ACOT program selected Enlaces for its first Innovative Scholars Award. The award has funded the seven-month residency at ACOT

in Cupertino of an Enlaces staff member who is writing a book on Enlaces and participating in a rich exchange of information and ideas with Apple staff.

III. Challenges Facing Enlaces

61. **Scaling Up.** The Enlaces project faces several major challenges in the years ahead. Having successfully launched the network as an experimental pilot project, a major achievement in itself, Enlaces now faces an even greater challenge- that of going to scale and becoming a truly national network. Making the transition from a pilot project to a full scale national scheme is a daunting task, particularly in light of the number of schools which remain to be served and the ambitious targets which have been set for the next few years. Enlaces, as noted, is aiming to incorporate all of the roughly 1,700 public and government-aided secondary schools and 50% of some 8,250 public and subsidized primary schools into the network by the year 2000.

62. In scaling up, Enlaces also faces a major challenge in achieving its important equity goals, particularly in rural areas. Chile has some 3,017 schools which are very small, with one, two or three teachers, multigrade, and in towns of some 300 persons. While on equity grounds, it would be desirable to include these schools in the network, many lack telephone communications. Moreover, the costs to serve these schools will be relatively higher than others with larger enrollments.

63. **Achieving Educational Benefits.** Perhaps even more challenging than expanding the network to scale in physical terms, is ensuring that teachers and students are able to achieve some of the educational benefits. However, achieving these benefits is not going to be easy judging from the experience of the United States and other countries. In many schools in the United States, the introduction of computers into the classroom rapidly outpaced the willingness and ability of teachers to use them for instructional purposes and, as a result, much of the technology has been seriously underutilized manner.

64. The universities which form part of Enlaces' new technical assistance network will have the main responsibility in helping schools to achieve their educational goals. Whether they are up to the task will only be known for sure at the end of 1997, when they have completed implementation of the first two-two year technical assistance plans. However, that might be too long to wait and too costly. Perhaps, some form of regular workshops with the univer-

¹⁰ It is important to note that at the secondary level, Enlaces is funding computer laboratories consisting of 11 computers, a network server, three printers, multimedia accessories, and software. The total costs of these laboratories and other expenditures have not been analyzed for this paper, but are not likely to be substantially different than the primary school costs. However, as Chile spends roughly twice as much per student at the secondary level as it does at the primary level, the annual costs per student will be half that of primary.

sity teams could be sponsored by the Ministry of Education to enable them to exchange experiences, strategies and know-how. These workshops could also help bring certain teams up-to-date on some of the more successful applications of computers in the teaching of science, mathematics and other subjects. They could also examine how best to use the World Wide Web and how to build up learning networks for teachers and students.

65. Building a Learning Network. The use of the Internet in schools is still in its infancy even in the developed countries. However, there are several pioneering experiences in the United States in the teaching of math and science using networks, which Chile will need to become familiar. These programs include GlobalNet, European School Project (ESP) operated out of the University of Amsterdam, NASA's SpaceLink, and many others. Chile will also want to begin to develop its own network resources for education, drawing upon its rich reservoir of historical, cultural, and scientific documents. It will also want to draw upon other Latin American countries' resources as they develop.

66. There are challenges to teaching and learning on-line successfully. Important questions need to be considered such as how to integrate networking into the curriculum, how to teach and learn on a networking system, and how to transform the network into an effective educational environment.

67. Maintenance, Repair and Replacement. Enlaces will soon have to establish some system for the maintenance and repair of computers in schools. While the first group of Macintosh computers purchased for the network are currently maintained under warranty by vendors, these warranties will begin to lapse in 1996. There are two main alternatives for dealing with maintenance, one is to establish a new system operated by the Government; the other is to contract private firms or the vendors for these services. Of the two alternatives, the private service approach would appear to be the most practical since Chile has a number of companies which already perform these services for private industry and do so effectively. However, the two alternatives and their costs will need to be assessed carefully, as well as how the maintenance expenditures are to be covered. Presumably, these expenditures will be covered by the municipalities as part of their responsibilities for the recurrent costs of the Enlaces project. However, for now most of the recurrent costs are for other items.

68. For now, Enlaces will need to concentrate on the maintenance, repair and replacement of Macintosh computers. Since Apple won all bids for computer equipment during the pilot phase, Enlaces only installed Macintosh computers in the schools. However, IBM recently won a large contract to provide computer hardware to some 190 new schools which also will require maintenance, repair and eventually replacement. Having to serve two different platforms will be challenging to Enlaces and could result in higher costs than

would otherwise occur, if the schools had only one platform. This is partly due to the fact that most repair firms specialize in one or the other platform, but rarely in both. The problem could become even more acute outside Santiago, where there are very few computer repair companies and even less who are equipped to handle both platforms efficiently.

69. Reducing Recurrent Costs. A major obstacle confronting Chile in fulfilling the promise of Enlaces and in sustaining it, is the project's high recurrent costs. As noted, these costs are averaging some US\$65 % of Enlaces' budget per month per school and some 80% of the costs stem from telephone charges. The municipalities which must pay these charges are growing more concerned about the high costs and are placing limits on these expenditures. It is not clear what effect these limits are having on the use of the network in schools, but there is little doubt that schools might become increasingly reluctant to use the Internet in order to keep telephone expenditures low. This problem may be especially acute for the schools in the poorer municipalities. One possible solution to these high recurrent costs would be to obtain special telephone rates for schools using the Internet. Such preferential rates for educational institutions using the Internet are becoming increasingly common in the United States and other countries.

IV. Conclusions

70. What are the main lessons to be drawn from Chile's experience which would be useful to other countries planning to introduce computers into their education systems? What are the lessons that can be learned from pilot experimental projects like Chile's which go to scale? What in particular can we learn about the special challenges of establishing an educational network? There are at least four relevant lessons:

71. First. The Chilean experience shows the importance of vision and sustained commitment to education reform by the Government. Without this vision of reform and the high priority attached to computers in education, it is very doubtful that the Enlaces pilot project would have been successfully implemented. Notwithstanding changes in Government, and the appointment of several different ministers of education, Chile's leaders have maintained a strong commitment to educational reform and to the goals of the Enlaces experiment. This strong and sustained commitment has also enabled Enlaces to mobilize vital support from regional and local authorities and from parents and community leaders. This support is proving crucial in enabling Enlaces to go from being a pilot experimental project to a major national program.

72. Second. Chile's experience confirms the benefits of having a sound strategic framework for project implementation. Chile's framework supports decentralized management of education which in effect means that: MECE takes the lead at the national level in

setting an agenda for reform but recognizes the importance of local initiative and of letting schools "reinvent themselves." By selecting schools to join the network on the basis of computer projects designed by the teachers and administrators, themselves, Enlaces fosters local initiative and self-reliance. In Chile each school decides for itself how best to use computers for improving teaching and learning rather than being dictated to by the Ministry of Education.

73. Third. Chile's achievements are due in no small measure to its considerable technical and managerial expertise. Any project like this one must have a solid professional team at the helm. The team which has managed the Enlaces network, including those in the universities, consists of highly competent and experienced computer engineers and other professionals. Several members of the team had worked for many years in developing the La Plaza interface and other technical solutions which have been implemented by Enlaces during the pilot phase. Such technical know-how and professional commitment are crucial both for establishing a computer network, as well as for operating and maintaining it. Countries can recruit some foreign expertise to help get started. However, there is little doubt that unless a country has their own technical and professional expertise for managing their projects, as well as commitment, they run the risk of failure.

74. Fourth. Chile's experience shows the benefits of starting a complex program as a pilot experimental project. If well conceived and well managed, a pilot can be highly effective in testing approaches, identifying solutions and building political support. Enlaces achieved many successes during the pilot phase and these successes gave the project tremendous momentum. The initial goal of establishing the network in 100 schools was by no means a modest one yet Enlaces surpassed the target and demonstrated the technical feasibility of the network.

75. Fifth. Chile's experience also emphasizes the importance of having well-developed and well-managed power and telecommunications infrastructure. Relatively noise free telephone lines, good bandwidth, and other infrastructural requirements are essential for a successful information and telecommunications programs. As there are no substitutes for this infrastructure, countries would be well advised to determine whether they have the critical minimum infrastructure for such programs or can obtain it, prior to making major financial investments in any networks.

76. The next five years will be an exciting period in the development of the Chilean learning network. Enlaces faces some formidable challenges but also great opportunities. Countries planning to introduce computers into education have a great deal to learn from the Enlaces experiment.

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TABLE 1 Costs of Computer-Assisted Instruction in Chile, Small School, ENLACES Program, 1995* (US\$)

Cost Category	Item	Useful Life (Years)	Unit Description	No. of Units	Average Unit Cost	Investment Cost	Annualized or Annual Cost**	%
COSTS								
INVESTMENT**								
Facilities	Comput. Rm., Renovation	15	Contract	1	\$ 500	\$ 500	\$ 99	2
	Furniture	10	Set	1	500	500	131	2
	Contingency & Other	10	2% of Facil.	1		20	5	0
Equipment	Server	5	Unit	1	1,830	1,830	849	14
	Computers	5	Unit	2	1,470	2,940	1,364	23
	Peripherals	5	Set	1	800	800	371	6
	Backup Generator	7	Unit	0	-	-	-	-
	Equipment Installation	5	30% of Equip.	1	-	1,670	775	13
	Contingency & Other	8	5% of Equip.	1		280	87	1
	Subtotal Facilities & Equipment					8,540	3,681	63
Software	Acquisition Cost	7	Set	1	350	350	122	2
Training (Upfront)	MOE Pymt per Sch.	7	Year	2	1,200	2,400	836	14
	Total Investment					\$ 11,290	\$ 4,639	79
RECURRENT***								
Personnel	Lab Coordinator		Annual Salary	0	-	-	-	-
	Other Personnel Services		Annual Salary	0	-	-	-	-
Maintenance	Equipment		10% of Equip.	1	541		541	9
	Software		Per Lic. Chg	1	-	-	-	-
	Routine		Year	1	-	-	-	-
Insurance & Theft				1	-	-	-	-
Training	Routine		Year	1	300		300	5
Utilities	Electric		Month	10	10		100	2
Telecommunications	Telephone		Month	10	15		150	3
	Internet Provider		Year	10	-		-	-
Computer Supplies			Month	10	15		150	3
	Total Recurrent						\$ 1,241	21
	Total						\$ 5,880	100
Cost Per Student (75 students)						Recurrent	Total	
						\$ 17	\$ 78	
% of National Primary Per-Student Recurrent Expenditures (US\$213)#						8%	37%	
% of National Secondary Per-Student Recurrent Expenditures (US\$427)#						4%	18%	
Students Per Computer								25
Source of Basic Data: Ministry of Education								
* Incomplete cost data.								
** Long-lived training, facilities and equipment costs are annualized, i.e., presented as average annual costs, using a 10% discount rate and with varying useful lives. Depreciation is included.								
*** Does not include marginal costs for classroom teacher time and computer room space, which are assumed to be zero, since the focus of the analysis is on affordability rather than cost-effectiveness.								
# Per-student recurrent expenditure is available only for primary and secondary education together (\$320 per student). These per-student estimates are based on the assumption that secondary expenditure is twice that of primary.								

TABLE 2 Costs of Computer-Assisted Instruction in Chile, Medium-Sized School, ENLACES Program, 1995* (US\$)

Cost Category	Item	Useful Life (Years)	Unit Description	No. of Units	Average Unit Cost	Investment Cost	Annualized or Annual Cost**	%
COSTS								
INVESTMENT**								
Facilities	Comput. Rm., Renovation	15	Contract	1	\$ 750	\$ 750	\$ 149	1
	Furniture	10	Set	1	750	750	197	2
	Contingency & Other	10	2% of Facil.	1		30	8	0
Equipment	Server	5	Unit	1	1,970	1,970	914	8
	Computers	5	Unit	5	1,470	7,350	3,409	30
	Peripherals	5	Set	1	1,110	1,110	515	5
	Backup Generator	7	Unit	1	-	-	-	-
	Equipment Installation	5	30% of Equip.	1	-	3,130	1,452	13
	Contingency & Other	8	5% of Equip.	1		520	162	1
Subtotal Facilities & Equipment						15,610	6,805	61
Software	Acquisition Cost	7	Set	1	490	490	171	2
Training (Upfront)	MOE Pymt per Sch.	7	Year	2	1,500	3,000	1,045	9
Total Investment						\$ 19,100	\$ 8,020	72
RECURRENT***								
Personnel	Lab Coordinator		Annual Salary	1	-	-	-	-
	Other Personnel Services		Annual Salary	1	1,000		1,000	9
Maintenance	Equipment		10% of Equip.	1	1,045		1,045	9
	Software		Per Lic. Chg	1	-		-	-
	Routine		Year	1	-		-	-
Insurance & Theft				1	-		-	-
Training	Routine		Year	1	400		400	4
Utilities	Electric		Month	10	20		200	2
Telecommunications	Telephone		Month	10	25		250	2
	Internet Provider		Month	10	-		-	-
Computer Supplies			Month	10	30		300	3
Total Recurrent							\$ 3,195	28
Total							\$ 11,215	100
Cost Per Student (200 students)						Recurrent	Total	
						\$ 16	\$ 56	
% of National Primary Per-Student Recurrent Expenditures (US\$213)#						8%	26%	
% of National Secondary Per-Student Recurrent Expenditures (US\$427)#						4%	13%	
Students Per Computer							33	
Source of Basic Data: Ministry of Education								
* Incomplete cost data.								
** Long-lived training, facilities and equipment costs are annualized, i.e., presented as average annual costs, using a 10% discount rate and with varying useful lives. Depreciation is included.								
*** Does not include marginal costs for classroom teacher time and computer room space, which are assumed to be zero, since the focus of the analysis is on affordability rather than cost-effectiveness.								
# Per-student recurrent expenditure is available only for primary and secondary education together (\$320 per student). These per-student estimates are based on the assumption that secondary expenditure is twice that of primary.								

TABLE 3 Costs of Computer-Assisted Instruction in Chile, Large School, ENLACES Program, 1995* (US\$)

Cost Category	Item	Useful Life (Years)	Unit Description	No. of Units	Average Unit Cost	Investment Cost	Annualized or Annual Cost**	%
COSTS								
INVESTMENT**								
Facilities	Comput. Rm., Renovation	15	Contract	1	\$ 1,000	\$ 1,000	\$ 198	1
	Furniture	10	Set	1	1,000	1,000	263	1
	Contingency & Other	10	2% of Facil.	1		40	11	0
Equipment	Server	5	Unit	1	2,020	2,020	937	4
	Computers	5	Unit	10	1,470	14,700	6,818	33
	Peripherals	5	Set	1	1,920	1,920	890	4
	Backup Generator	7	Unit	1	-	-	-	-
	Equipment Installation	5	30% of Equip.	1	-	5,594	2,594	12
	Contingency & Other	8	5% of Equip.	1		931	291	1
Subtotal Facilities & Equipment						27,205	12,002	57
Software	Acquisition Cost	7	Set	1	490	490	171	1
Training (Upfront)	Lab Coord. & Instructors	7		1	2,000	2,000	697	3
Total Investment						\$ 29,695	\$ 12,869	61
RECURRENT***								
Personnel	Lab Coordinator		Annual Salary	1	4,200		4,200	20
	Other Personnel Services		Annual Salary	1	-		-	-
Maintenance	Equipment		10% of Equip.	1	1,863		1,863	9
	Software		Per Lic. Chg	1	-		-	-
	Routine		Year	1	100		100	0
Insurance & Theft				1	-		-	-
Training	Routine		Year	1	500		500	2
Utilities	Electric		Month	10	40		400	2
Telecommunications	Telephone		Month	10	40		400	2
	Internet Provider		Month	10	-		-	-
Computer Supplies			Month	10	60		600	3
Total Recurrent							\$ 8,063	39
Total							\$ 20,932	100
Cost Per Student (1000 students)						\$ 8	\$ 21	
% of National Primary Per-Student Recurrent Expenditures (US\$213)#						4%	10%	
% of National Secondary Per-Student Recurrent Expenditures (US\$427)#						2%	5%	
Students Per Computer								91
Source of Basic Data: Ministry of Education								
* Incomplete cost data.								
** Long-lived training, facilities and equipment costs are annualized, i.e., presented as average annual costs, using a 10% discount rate and with varying useful lives. Depreciation is included.								
*** Does not include marginal costs for classroom teacher time and computer room space, which are assumed to be zero, since the focus of the analysis is on affordability rather than cost-effectiveness.								
# Per-student recurrent expenditure is available only for primary and secondary education together (\$320 per student). These per-student estimates are based on the assumption that secondary expenditure is twice that of primary.								