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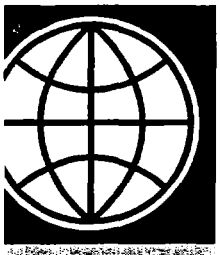

Human and Social Development Group
LATIN AMERICA AND THE CARIBBEAN REGION

COMPUTERS IN THE SCHOOLS: Chile's Learning Network

by
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LASHC Paper Series No. 4

July 1996

CHILE'S LEARNING NETWORK

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I. PREFACE.

1. In today's schools, computers are used as much for communication purposes as they are for computing. Computer-mediated Communication (CMC) using telephones and satellites offers many promising opportunities for teachers and students to become a part of learning networks. The use of computer networks at all levels and types of education introduces new ways to transform the way teaching and learning takes place. Use of such networks is generating enthusiasm among educators and students alike, who find that networking technologies improve traditional ways of teaching and learning and provide new possibilities for interactive communication, collaboration, and knowledge-building. Indeed, the convenience and effectiveness of this new mode of learning should make it a major educational tool in the twenty-first century. (Harasim, Linda et al., 1995).

2. This study[1] focuses on a unique experiment with computers that is taking place in Chile. The purpose is to establish an information and communications network among the nation's public primary and secondary schools. The network is called Enlaces (Links), and is a part of the Chilean Government's major educational reform program (MECE). Its objective is to improve the quality, efficiency, and equity of primary and secondary education. Enlaces is the creation of Pedro Hepp, a computer engineer, formerly on the Faculty of Engineering at the Catholic University in Santiago where pioneering work had been undertaken to build communication networks among Chile's higher education institutions. Established in 1993 as a pilot demonstration project in the southern part of the country, Enlaces subsequently built a remarkable network among some 180 primary

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1 This study was prepared during a brief sabbatical leave the author spent at Harvard Graduate School of Education, SRI International, and other organizations. My leave from the World Bank was made possible by the generous support provided by the LAC Vice President's Scholarship Fund and LA3HR. I should especially like to thank Shahid Burki, Vice President, LAC and Julian Schweitzer, Division Chief, LA3HR for their support. I also wish to thank Cristian Cox, Director of MECE, Pedro Hepp, Maria Ines Alvarez and the other Enlaces staff for their cooperation and assistance, Pedro Hernandez of Apple Computer Corporation for his thoughtful comments on an early draft of the study, and Douglas Adkins for his assistance in analyzing network traffic and cost data.

and 62 secondary schools, trained hundreds of teachers in its use, and is supplying educational software (e.g., "La Plaza," para. 34.). Most significantly, a majority of the schools in the pilot program are located among the country's poorest communities, mainly in indigenous areas, where educational resources are scarce. And most importantly, there is growing evidence that the computing and communications technology provided by Enlaces is contributing to change conventional attitudes about teaching and learning approaches in Chile's schools.

3. Given the success of 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 by having to work with some new partners: namely, the universities and IBM. The nation's universities now form part of a technical assistance network established by the Ministry of Education to help Enlaces provide network schools with the requisite 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 initially provided most of the hardware and considerable technical assistance) in helping Enlaces expand its network in the years ahead.

4. **Purpose of Study.** This study examines the Enlaces project and the role of Chile's learning network in the framework of the country's overall educational reform agenda at the primary and secondary levels. The study examines a number of important issues related to the design and implementation of networks drawing on the Chilean experience. These include: How should the objectives of learning networks be defined? What are effective strategies for their implementation? What type of training and technical assistance are required? What kind of monitoring and evaluation studies might be undertaken to assess the progress and impact of a network? What are the investment and recurrent costs of a network and are such networks affordable at the size and scale contemplated ? The study also reviews the many challenges facing Enlaces in the years ahead as it moves from a pilot experimental project to a national program. The concluding section draws some lessons from the Chilean experience that could be helpful to other countries in defining the role of the Internet and its linkage to classroom-based 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 networks. The Chilean experience 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 use of technology in education, and the benefits of starting with good pilot projects and then going to scale after gaining knowledge and experience. Chile provides an example of how one country is attempting to modernize its education system by the use of computers, thereby positioning itself for the important role

knowledge-based economies will play in the years ahead. Assuming Enlaces will successfully meet the challenges ahead, and that educational reform will achieve its human development goals, Chile should be well-positioned for economic growth and social development in the new information age in the next century.

II. BACKGROUND

6. **Chile's Educational System**. Chile has a population of close to 14 million. Its education system compares favorably with its neighbors and with higher income economies as well. Adult literacy is about 95 percent and average years of schooling now attained by Chileans is nearly 10 years. Access to primary education is essentially universal, secondary education is available to some 82 percent of the student population, and enrollments in higher education, although relatively limited, are rapidly expanding. In the mid-1990s, total pre-university enrollment in Chile amounted to some 3 million students who attended over 15,700 schools; close to 2 million attend primary school , 653,000 secondary schools, and the rest are in preschools. Higher education enrollments reached some 285,000) students who attend some 34 universities, 133 technical centers, and 53 professional institutes.

7. Despite these impressive achievements, Chile's education system faces difficult problems of 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. These levels are also characterized by high inefficiency reflected in late primary school entrance, high repetition rates, and high dropout 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 critical (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 5 percent of those belonging to the lowest-income households participate in tertiary education, compared to 45 percent of higher-income households.

8. The shortcomings of the system can be traced 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. 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, which is essential to improve the quality of educational services.

9. The financing and management of education is a responsibility shared between the central government and municipalities. Under this arrangement, preschool, primary and

secondary schools are administered by the country's 334 municipalities. The municipalities are completely autonomous in the management of material, financial, and human resources, as well as the school maintenance. However, all municipalities receive educational resources from the central government based on average monthly student attendance. The central government also encourages (through a per student subsidy) private individuals and non-governmental organizations to create tuition-free schools.

10. Although the current management system in its decentralized form has many positive features, the institutional capacity for managing education is generally weak at all levels. The Ministry of Education has difficulty 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 mean that primary and secondary schools operate with considerable autonomy and little accountability.

11. **Education Reform.** In 1991, Chile launched an ambitious educational reform program that 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; as well as to provide in-service training for some 78,000 teachers and 8, 000 principals; distribute textbooks and complementary reading materials; upgrade and expand school infrastructure; and establish the Enlaces experimental network in some 100, mostly rural primary schools. MECE also aimed to strengthen the planning and administrative functions of the Ministry 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 was highly successful in achieving its objectives, which encouraged the Chilean Government to proceed with the implementation of a similar reform at the secondary level.

12. Chile's Secondary Education Quality Improvement Project (MECE-EM) was launched on an experimental basis in 1994 in 124 secondary schools and became a full-scale national program by 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 enhance teaching and learning of higher-order thinking and problem-solving skills; funding educational development projects (PDEs) prepared by the schools; and providing educational resources, such as textbooks, school libraries, teaching materials, infrastructure and computers. The idea also is to improve the external efficiency of secondary education by better linkages between technical-vocational secondary schools and the private sector, specifically for curriculum development, skill certification, in-service teacher training, and use of physical facilities. Lastly, building on sector management strengthening activities launched under MECE, improvement will be sought in: leadership and management of principals and heads of curricular subject areas; establishing and maintaining a technical support network of universities and other entities

that would provide technical assistance to participating secondary schools in training; and developing learning materials, and identifying curricular needs.

13. **Enlaces Today**. Enlaces wisely began as a pilot program. It was launched in March 1993 with the goal of creating a telecommunication and computer network among 100 Chilean primary schools and affiliated institutions by 1997. Some 70 percent of the schools in the network were located in Chile's southern region, 20 percent 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, MECE set new even more ambitious objectives for Enlaces: to have 50 percent of all primary schools and 100 percent of all secondary schools in the network by the year 2000. In addition, Enlaces now 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.

Table I

Enlaces Network Centers: Actual and Planned Growth, November 1995

	Primary			Secondary			
Year	Actual	Planned	Subtotal.	Actual	Planned	Subtotal.	Total
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

15. The plans for the next five years foresee a substantial increase in the number of new centers joining the network 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. This is ambitious, but feasible. On the other hand, in 1997 and 1998, the projected increases of 16 and 25 percent, respectively, over current levels will require some rethinking of Enlaces' current delivery system.

16. It is often said that Government leaders dislike pilot projects because they offer little by way of political returns and are difficult to dimension after the pilot. However, the Chilean Government has shown that a well-managed pilot can be a good way not only to demonstrate the feasibility of a large-scale project but build important political support for its implementation and sustainability as well.

17. As Enlaces moves from its pilot phase to a national program, it will have strong political support given its initial success. 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 children will

gain important advantages in education and employment from learning with computers in school. Sustained national and local government support will be crucial to the success of Enlaces in view of the project's substantial investment requirements and annual recurrent costs.

18. **Goals and Expectations.** What are the Government's goals and expectations in investing in Enlaces? Are they realistic in light of the experience in other countries? Can then be translated into operational activities? What is the Government's timetable?

19. Enlaces published several documents about its goals and expectations[2] that bear eloquent testimony to the evolving experience during the pilot phase. Current expectations of information and communications technology are both educational and socioeconomic in nature. Enlaces' main administrative 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. This is expected to promote several benefits:

-- ***Equity and decentralization.*** Members of an educational establishment would become part of a school community regardless of their geographic location. Also, teachers in the network would have access to the same information and projects regardless of their location.

-- ***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 students and teachers in one school with those of another school. In particular, computers are expected to foster 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 curricular perspective, the network would produce a gradual integration of course content across the curriculum.

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[2] See Enlaces (Diciembre, 1994) "Informatica Educativa Principios y Usos," Monografia No 4, Enlaces. (Enero 1995), Enlaces - Basica Estado de Avance Fundamentos" world wide web site: http://enlaces.ufro.cl.

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

20. Enlaces also envisaged important social and economic benefits the country could expect to obtain by the introduction of information and communications technology in schools. Youth will later become change agents by introducing computers in the productive and service sectors. Youth will also benefit from high level thinking skills stimulated by computer learning which are vital to contemporary society: the ability to develop research strategies and selection criteria; the ability to process information, organize and plan activities, and the capacity to communicate effectively and coherently, presenting written ideas independently and creatively. Finally, with the possibility of global communications during their school years, students will develop a world vision and the skills to communicate effectively in the international arena.

21. Enlaces' goals and expectations are highly ambitious, yet generally well-conceived and worth pursuing. Monitoring and evaluation studies carried out during the pilot phase (discussed below) indicate that Enlaces has been doing well in school and meeting many of its goals. It has done so, by absorbing lessons learned from the United States and other countries during the 1980s and adapting them to the Chilean context. There are four main lessons that 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 that support their educational activities. This process builds ownership and commitment to change. Dictates from above are generally counterproductive; and

(d) The introduction of technology in schools should 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 most advanced in Latin America. Heavy public and private investment in the sector in the past two decades has given the country a backbone of copper and fiberoptic cables. Since 1991, Chile has had Internet connections covering a large portion of the country; today it has five separate international connections

provided by five different companies. Two companies Reuna and RDC, the oldest Internet service providers, provide national Internet links. Reuna is different from the other companies in that it is a consortium of state universities that have combined to establish an extensive digital backbone, offering 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 throughout 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 occurs by conventional telephone lines and UUCP (Unix-to-Unix-copy) protocols. Those schools that comprise the Enlaces network can communicate with each other using E-Mail and Bulletin Boards with standard Internet addresses. Electronic mail messages can be sent to and received from abroad at no additional costs to the school by using Chile's university networks as Internet gateways.

24. All schools in the Enlaces network now have the potential to be linked to the Internet, but lack direct lines or service providers; this means their connection permits them to receive text but no graphics or sound. However, this environment is changing fast. Enlaces launched an experiment with the Compania de Telefonos de Chile to connect schools directly to the Internet via fiberoptic cables. Twelve schools in the Temuco area already are connected and others will follow suit. The cost of connections and service will be provided by the company free of charge for a year, during which time it will determine an appropriate 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 (like the southern part of the country) and have no telephone service. To provide network access to these schools, Enlaces has begun experimenting with packet radios, ultra high frequency (UHF) channels, and the TCP/IP protocol. Enlaces was able to link four schools within a 20 kilometer radius, located in areas without major geographic obstructions, to 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 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 this technology can be used effectively only where there are no topographic obstructions.

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

26. **Strategy.** Enlaces has adopted a gradualist, demand-oriented strategy for network expansion at the primary level 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, when schools wish to become part of the network, they must demonstrate their commitment by applying officially, present a proposal about how they intend to use the computer network in their educational programs, and agree 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 related items.

27. The strategy for expanding the network in secondary schools is different. Instead of following a gradualist, demand-oriented strategy, as at the primary level, Enlaces plans to incorporate all 1,700 public and government-assisted private schools into the network by the year 2000. 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. Criteria would be similar to those in use 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 six times the current rate [4] 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 installation.

28. **Provision and Access to Computer Equipment.** Primary schools accepted into the network are given computer equipment, software, furniture, and teacher training by Enlaces. The number of computers allocated to each school is determined by enrollment. The Enlaces formula is a 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 in the small school; and a large school (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 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 10 Base Tethernet cards. For internal communication schools use Macintosh *system 7* or *Workgroup for Windows 95*, depending on the platform.

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[4] This conclusion is based on the premise that Enlaces has 5 years to reach 1,700 schools; the current number is 120. At a minimum, it would need to increase installations to 370 a year, compared to some 60 a year during the first two years.

29. Secondary schools, in contrast, are 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 also would be incorporated into the network wherever possible.

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

Table II
Average Maximum Weekly Computer Access by School Size
(minutes per student)

	50/100 students	100/300 students	600 students	1000 students
3 computers	108/54 min.	-		
6 computers		54/36 min.		
9 computers			27 min.	
11 computers				33 min.

31. Table II shows that the maximum amount of time that each student has on a computer working alone would be close to an hour in 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 time per student 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. Some are limiting access only to students in certain grades on the basis of motivation, interest, and other criteria. Others give all children some access to computers -- 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. 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 with a good basic collection of software. This software consists of titles produced in Chile for educational use and titles produced in the United States commercially available in Spanish. One of the most comprehensive pieces of software used in Chile today is La Plaza, which was produced first by Pedro Hepp and his colleagues and has been elaborated 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 percent Chilean, although its features can be used easily or adapted to all Latin American countries that have "plazas".

34. ***La Plaza.*** La Plaza (the square) is a software program written in C++ with a friendly-looking, 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 (presented in Figure 1) shows four buildings which are familiar sites in most Chilean towns and villages: a post office, a kiosk, a museum, and a cultural center.

Figure 1.

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 also purchased site licenses for some 30 different software titles and distributed different titles to a small group of schools.

An additional 10 multimedia educational applications developed in Chile are also given to schools. Finally, the "Centro Cultural" or 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 use of technology in schools. If 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 good chance the school will achieve significant educational benefits. In Chile, as in most other countries, primary school teachers generally greeted the introduction of technology with both enthusiasm and fear. 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 fear comes from unfamiliarity with technology: most teachers will not grow up with computers and doubt they will ever learn to integrate it effectively into their institutional framework. While the majority of teachers are willing to try to overcome their fears, and do eventually learn to use technology effectively, there are some who are unwilling or unable to change.

36. The training strategy adopted by Enlaces is based on the notion that no single solution fits all schools and that training must equip teachers to find their own solutions. Attempts have been made to train as many teachers as possible in each school so they can use computers in their teaching and avoid the experience of the past 10 years when only one "expert" laboratory instructor held sway over the rest of the teachers. Lessons from Apple Computer Corporation's Apple Classrooms of Tomorrow (ACOT) are also guiding Enlaces' training strategy, 2 months, such as the value of training two coordinators in each school to work as a team the benefits of involving teachers in hands-on computer training in the classroom.

37. Enlaces has provided in-service training to school administrators and teachers in all schools in 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 provided training in two phases. "Initial training," obligatory for all schools joining the network, has been held on site, soon after a school's computers are installed. This training consists of six two-hour sessions weekly focusing on helping teachers to overcome their fears of 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 on 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, spreadsheets, and other productivity tools, *KidPix*, and their use in teaching.

38. Enlaces also has 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 respective roles

and responsibilities. The coordinators are to provide technical, administrative, and general support to other teachers and the school director. They work with the school director in scheduling computer use, 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 are often used to help schools reformulate their original projects for using computers to increase their effectiveness.

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 that 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 centers, each located in one of four large zones; the heavily populated central zone covering Santiago and Valparaiso has four centers. Each Zone Center is located in a Chilean university, which, under contract with the Ministry of Education, will provide a range of technical assistance and support services to the network schools in their respective zones. In some instances, a center might subcontract other entities in the zone to help provide required services and technical support.

40. Each center has a detailed work plan for 1996/97 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 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. At the end of two years, each school joining the network would be expected to reach a stage of independence in using and maintaining computers. To determine whether schools actually achieve this stage of maturity, Enlaces developed a series of indicators of attitudes, teaching practice, and skill development. These indicators will prove useful in assessing the qualitative outputs of the technical assistance network.

41. The 1996/97 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 receiving 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

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[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.

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, especially CD-ROMs, and providing teachers with articles and other information on constructivist teaching methods and how to use telecommunications in their pedagogy.

42. **Monitoring and Evaluation**. Few programs systematically monitor and evaluate their operations. It is, to Enlaces' credit that it regularly monitors the operations of the network and supports 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 use at each node. Its monitoring focuses on the use of the network, attitudes and perceptions of users, and changes that occur in 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 monitoring of network traffic and research at the school level.

43. What changes can be expected in the teaching and learning taking place in Chilean schools as a consequence of the network?[6] What kind of evaluation is Enlaces undertaking. According to Maria Ines Alvarez (m.d.), Enlaces is contemplating seven different evaluation formats:

- The impact of introducing computers in terms of achievement of the main curricular objectives. The national evaluation system already existing to measure changes in academic variables will be used.

- Psychological variables of students are 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

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[6] According to a recent survey of 240 United States teachers and learners on the Internet, 70% said their experience in using networks 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 said 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 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."

perceptions about the teachers, cognitive development levels, social relationships and academic self-concept.

- Changes in teachers include 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 include the following aspects: perceptions about the school, about teachers, and perception and commitment to their children's scholastic experiences.

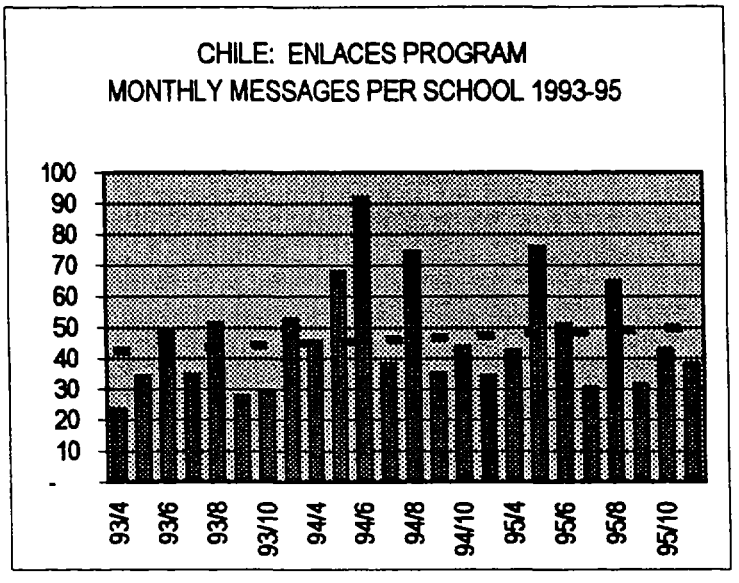
- Traffic levels and software uses over the time and related to the variables mentioned above. Evaluation of the relation of traffic levels to the growing levels of the network (numbers of schools and other institutions involved).

- Communication relationships with an adapted sociogram, 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 constituting of a town and the relations among subnetworks.

- 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 has provided useful data on network usage patterns over the past two and a half years. For example, 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 between and 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 the outside world. Some 35 percent of all messages are sent outside Chile. The monitoring data also make it possible to determine whether E-Mail traffic within the Enlaces network grew in absolute terms or proportionally to the number of centers that have joined the network. The average monthly total of messages per school during the 1993-95 period varied only slightly (see Table III):

Table III



In 1993, the average monthly messages per school were 38, while in 1994 they increased to 54, and dropped to 47 in 1995.

45. Enlaces has also conducted some evaluation studies to assess changes in schools.[7] To measure changes, from 40 schools in the network at that time, a sample was selected of some 350 teachers, 3,000 students and 1,500 parents or guardians, using variables such as: educational level, geographical distribution, and population density. The study found increases in creativity among 28 percent of the students, significant indications of change in flexibility, originality and other thinking skills among 35 percent of the students, and some significant increases in cognitive development among 75 percent of the students. These highly positive findings will need to be confirmed in subsequent research.

46. Other research by Enlaces shows positive changes in teachers' attitudes towards teaching, computers, and the benefits of the network in their teaching. They also report positive changes in student attitudes and a significant increase in creativity. A survey of some 70 teachers carried out in December 1994 in network schools in Temuco showed that teachers were generally highly satisfied with the network and the benefits 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 achieving the goals of Education for All (Nunez 1995). He reports that school directors, teachers and students spoke highly of the network and claimed many benefits, such as: reductions in school dropouts; improvement in achievement among slow learners, hyperactive and disruptive

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

students; and excitement about being able to communicate with other schools. School directors and teachers felt positive about their schools being able to have the same resources available at schools in higher-income communities. They also reported on a number 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, who had difficulty with 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 that 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 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 of Enlaces? How many people does it take to run a program of its size efficiently? The director of the Enlaces project reports to the head of MECE and regularly consults with him on policy and strategic issues affecting the network. Based on the management style of Cristian Cox, the head of MECE -- but also due to the confidence he has in Enlaces' director, Pedro Hepp -- he has given Enlaces great autonomy in managing its program activities. The director also enjoys a great deal of autonomy since he is located in the southern part of the country.

50. From the beginning, Enlaces has operated out of two centers: one located in the Department of Computer Sciences at the *Pontífica Universidad Católica* de Chile (PUC) in Santiago, and the other on the campus of the *Universidad de la Frontera* (UFRO) in Temuco, several miles from Santiago. The headquarters of Enlaces is located at UFRO, the result of the university having won a government tender to manage the network for four years beginning in March, 1993. Enlaces' offices are located in a modern 600 sq.m. 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 maintains a 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

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

designers, teachers, graphic designers, and journalists. Its administrative, financial and legal affairs and procurement activities are 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 percent of the total allocation will be spent on equipment and 25 percent on training and technical support. The Government has committed all the funding required to achieve the targets for secondary education; however, it currently has 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 precision because Enlaces has not collected cost data on several key cost items essential for this kind of analysis. However, using 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. These numbers are tentative due to the lack of hard data on all project costs. Enlaces recently began to collect this data systematically; hence, there will be more precise cost data in future with which to up-date this analysis.

54. The cost analysis of the Enlaces project was done using standard methods[9] for small (75 students), medium (200 students), and large (1,000 students) schools. The cost tables for each size school are shown in Annex I, Tables 1,2, and 3. These tables, the total investment and recurrent costs range from US$5,880 for a small school to US$20,932 for a large one. Like most projects of this kind, the cost of facilities and equipment, renovations and furniture, computers and related hardware and software roughly average about 60 percent of total annualized costs. The remaining costs -- training, personnel, supplies, maintenance, and communications -- are about 40 percent.

55. The analysis shows significant variations in the percentage of investment and recurrent cost by school size. While in a small school investment costs are 79 percent of total costs and recurrent costs 21 percent, in a large school they are 61 percent and 39 percent, respectively. These variations are mainly due to the different assumptions made about staffing and other requirements of different size schools. Since small schools have few computers, there is no need to assign coordinators exclusively for the management of computers. However, large schools have computer labs and a significant number of computers, and thus would need to have a full-time lab coordinator. Where full-time lab

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[9] In a standard cost analysis of this type, long-lived investment costs are expressed as annual costs that account for financial cost (equivalent to an annual installment payment over the life of the asset) plus depreciation.

coordinators are required to run computer projects, their salary increases 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.[10] For a small primary school with 75 students, total project costs average $78 per student annually; however, of this amount, only $17 is for recurrent expenditures. This amount is roughly equivalent to about 8 percent of Chile's annual per student recurrent expenditures in primary education ($213). Total per student costs are somewhat higher for middle size and large schools. Project costs for a primary school with 200 students are $56 per student annually, but recurrent costs are about the same as for the smaller school ($16) and equal 8 percent of annual per student costs. Annual per student costs drop considerably in large schools to $21 per student and 4 percent of recurrent expenditures. [11]

57. These low recurrent costs are due to two major factors. The first and most important is that the ratio of computers to students is low in most schools. In the small schools the ratio is about 1:33 while in the large schools 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 underestimated, such as software and professional expenses. Comparison of Enlaces' recurrent costs to those of another computer project in Chile (Genesis) shows significant differences. For example, where Enlaces' recurrent costs range from 21 percent in a small school and 39 percent in a large schools, they are 46 percent 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. It has tried to get the best and latest hardware available, but has 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

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

[11] At the secondary level, Enlaces is funding computer laboratories consisting of 11 computers, a network server, 3 printers, multimedia accessories, and software. The total costs of these laboratories and other expenditures have not been analyzed in this paper, but are not likely to be substantially different than primary school costs. However, as Chile spends roughly twice as much per student at the secondary as it does at the primary level, the annual cost as a percentage of total per student expenditure on secondary education will be half that of the equivalent expenditure on primary.

development and teacher training that should lead to the effective deployment of computers in schools.

59. Enlaces is planning to follow a cofinancing 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 poorer communities. It 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 will not be inclined, under the current financing arrangements, to continue to cover costs that ultimately are considered a local responsibility.

60. **Role of Apple Computer Corporation.** 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 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 that remain to be served and the ambitious targets set for the next few years. Enlaces is aiming to incorporate all of the roughly 1,700 public and government-aided secondary schools and 50 percent 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 (between one and three teachers), multigrade, and in towns of about 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. Achieving these benefits will not 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; as a result, much of the technology has been seriously underutilized.

64. The universities that 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 by 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 type of regular workshops with the university 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 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 foster 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 developed countries. However, there are several pioneering experiences in the United States in the teaching of math and science using networks with which Chile will need to become familiar. These program include GlobalNet, a European School Project (ESP) operated by the University of Amsterdam and NASA's SpaceLink. Chile will also want to begin to develop its own network resources for education, drawing on its rich reservoir of historical, cultural, and scientific documents. It will also want to draw on other Latin American countries resources as they develop in this area.

66. There also are challenges to teaching and learning on-line successfully. Important questions including how to integrate networking into the curriculum, how to teach and learn in 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 a system for the maintenance and repair of computers in schools. While the first group of Macintosh computers purchased for the network is currently maintained under warrantee by vendors, this warranty 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 that already perform these services for private industry. 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, 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 if the schools had only one platform. This is partly because most repair firms specialize in one or the other platform, but rarely both. The problem could become even more acute outside Santiago, where there are very few computer repair companies, and almost none 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 $65 percent of Enlaces' budget per month per school and some 80 percent of the costs stem from telephone charges. The municipalities that must pay these charges are growing more concerned about the high cost 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 to keep telephone expenditures low. This problem may be especially acute for schools in 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 more common in the United States and other countries.

70. **IV. Conclusions.** What are the main lessons to be drawn from Chile's experience that would be useful for 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 five 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 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 that have been implemented by Enlaces during the pilot phase. Such basic 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 its own technical and professional experts for managing projects, as well as commitment, it runs the risk of failure.

74. Fourth. Chile's experience shows the benefits of starting a complex program as a pilot 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 demonstrate 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 program. 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 can learn a great deal from the Enlaces experience.

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TABLE 1 Costs of Computer-Assisted Instruction in Chile, Small School, ENLACES Program, 1998* (US$)

Cost Category	Item	Useful Life (Years)	Unit Description	No. of Units	Average Unit Cost	Invest-ment 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	3,881	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	$ 4,839	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

	Recurrent	Total
Cost Per Student (75 students)	$ 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, 1998* (US$)

Cost Category	Item	Useful Life (Years)	Unit Description	No. of Units	Average Unit Cost	Invest-ment 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**	**6,806**	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						**$ 18,100**	**$ 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							**$ 3,196**	28
Total							**$ 11,216**	100

	Recurrent	Total
Cost Per Student (200 students)	**$ 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.

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