Computers in Schools: A Qualitative Study of Chile and Costa Rica

by

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Summary Report of a Collaborative Research Project

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Abstract

This qualitative analysis explores Chile and Costa Rica’s experiences introducing technology into their education systems at the program, school and classroom levels. The interview and observational data collected in 11 schools, selected because of their success with implementing technology programs, report how principals, teachers and students perceive and use technology. At the program level, the analysis reveals that the choice of implementation strategies for launching and disseminating a technology program has important implications for how the program is applied in the schools. At the school level, the programs have led to greater prestige, pride and opportunities for professional development, particularly among teachers. In the classrooms and computer laboratories, patterns of social organization within classrooms echo those observed in computer laboratories where the research recorded increased interaction among students and less direction on the part of teachers.

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I. INTRODUCTION

Chile and Costa Rica provide a valuable opportunity to analyze two approaches to introducing computers into developing-country education systems. Both are democratic, middle-income countries; both have focused their computer-based education programs on schools in low-income urban and rural areas; and both intended that computer use would enhance children's cognitive abilities and prepare teachers and students to participate more fully in the Information Age. However, these two countries took quite different approaches to the ways in which the computers were used in their schools. Their approaches offer insights into designing and implementing technology programs which enhance teaching and learning in schools.

Study Purpose. In early 1996, a set of qualitative case studies was initiated to analyze the role of computers in education in Chile and Costa Rica. The analysis was conducted at the program, school and classroom levels. At the program level, the study focused on the goals of the technology programs and the strategies adopted for achieving these goals, with a particular focus on lessons that could be useful to other countries using computers to support education in the coming years. At the school level and classroom, 11 schools (6 in Chile and 5 in Costa Rica) that had successfully introduced technology programs were studied to assess the resulting changes in the roles and behaviors of students and teachers. Whereas this study provides insight into each country’s experience with education technology, a much larger, prospective study based on a random sample of schools would be needed to provide generalizable, systematic evidence concerning outcomes.

Chile’s Computer Program. Chile launched Enlaces as a pilot project in 1993 as part of a much larger and more comprehensive reform to enhance the quality of primary and secondary education. The goal of Enlaces was to create a telecommunications and computer network among 100 Chilean primary schools and associated institutions, with the intent that the computers could be used to promote cooperative learning, higher-level thinking, data management, and communications skills. As part of the school selection process, individual schools were invited to submit proposals to describe how they intended to use the computers within the context of an overall school improvement effort. By the end of 1995, Enlaces had substantially surpassed its original targets and had incorporated computers into some 180 schools at both the primary and secondary levels. However, this number is only a very small percentage of Chile’s 8,250 primary schools and 1,700 secondary schools.

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. By the end of 1997, there were close to 900 primary schools and 450 secondary schools engaged in the Enlaces network, supported by 26 universities providing training, pedagogical guidance and technical support to the schools.

Costa Rica’s Computer Program. Originally launched as a campaign promise of the former president and Nobel Peace Prize laureate, Oscar Arias, the Costa Rican Computers in Education Program was created in 1988 to contribute to the improvement in the quality of Costa Rican education and to provide access to technology to children in rural and marginal urban areas. The program, which is a joint effort of the Ministry of Public Education and the Omar Dengo Foundation (ODF), has been designed to stimulate creativity, cognitive skills and collaborative work. Other project objectives have been to rekindle teachers’ interests in teaching and to provide students with new learning environments and opportunities. The program reaches yearly 30 percent of the total elementary school
population and is present in all regions of the country. It is based on a constructivist approach to learning and uses *Logo* as a programming tool and a vehicle for creating a constructivist educational environment. The specific program used till 1997 is *Logowriter*, which has both graphic and word processing capabilities making it possible to address different curriculum related subjects through the development of specific projects.

From the beginning, teacher training, follow up and support have been key components of the Costa Rican program. The initial program design was jointly developed by a Costa Rican team with the support of Seymour Papert and other members of the Learning and Epistemology Group of the Massachusetts Institute of Technology (MIT). It included training of a core group of trainers and program staff from the Omar Dengo Foundation, the Ministry of Public Education and the University of Costa Rica. The primary focus of the training developed with the initial support of Papert and MIT was centered on educational philosophy and fostering constructivist practice in the use of computers. Technical and programming aspects have always been intertwined with educational aspects through a project-based approach. Technical content per se has always had a secondary focus.

Historically, the Omar Dengo Foundation has been responsible for technical, pedagogical, logistic and financial support. In order to guarantee adequate program development, Omar Dengo Foundation created a Training and Research Center which has been responsible for the creation of training modules and on-going support since 1988. Since its inception, the Costa Rican program has reached over one million children, teachers and adults.

**Country Backgrounds**

**Chile’s Education System.** With a population of close to 14 million and a per capita GNP of $2,700, Chile has a well-developed education system which compares favorably to its neighbors and to higher-income countries. Adult literacy is about 95 percent, with an average of 10 years of schooling now being attained by Chileans. Access to primary education is essentially universal, while secondary education is available to some 82 percent of the student population, and enrollment in higher education, while still limited, is expanding rapidly.

Despite these impressive achievements, Chile’s education system has faced difficult problems in quality, efficiency and equity, especially in schools serving low-income urban and rural communities. Low standardized test scores have revealed poor mastery of curriculum objectives by both primary and secondary school students; repetition and dropout rates were high; and many schools in rural areas have not offered the complete cycle of primary education. Secondary education also has shown low external efficiency, failing to provide students with the higher-order thinking and problem-solving skills required by tertiary education institutions and the labor market. Moreover, there have been severe disparities between higher and lower income groups in the quality and access to educational services at the primary, secondary and tertiary levels.

In 1991, Chile launched an ambitious educational reform which began with a Primary Education Improvement Project (known by its Spanish-language acronym, MECE), a $243 million 5-year program to improve the quality, efficiency and equity of its primary system. Under the MECE program, Chile allocated grants to some 5,000 municipal schools to fund innovative multi-year quality improvement projects designed by the schools, provided in-service training for some 78,000 teachers and 8,000 principals, distributed textbooks and complementary reading materials, upgraded and expanded school infrastructure, and established the *Enlaces* computer network in 100 mostly rural primary schools. In its first years of operation, MECE was judged to be highly successful in achieving its objectives, giv-
ing encouragement to the Chilean government to proceed with the implementation of a comparable reform at the secondary level. Chile embarked on a second phase of MECE in 1994 through the Secondary Education Quality Improvement Project which was initiated on an experimental basis in 124 of the 1200 secondary schools in the country and became a full-scale national program in January 1995. Today, MECE includes a variety of other initiatives serving at-risk students, preschoolers and accelerated secondary schools.

Costa Rica’s Education System. Costa Rica is a much smaller country than Chile, but comparable in its level of economic development. Costa Rica’s population of 3.5 million has an annual per capita income of US $3,659. It has enjoyed an enviable position among Latin American countries in the provision of social services, including education. Universal primary education was achieved by the early 1960s and by 1995, adult literacy stood at 95 percent. Over 80 percent of Costa Rican elementary school students continue on to secondary school, a number that is rising due to the creation of new high schools in recent years. Costa Rica has 4 state universities, 4 community colleges, and 39 private universities along with a wide range of non-formal technical, commercial, and agricultural courses are offered throughout the country by the National Training Institute.

During the mid 1980s, Costa Rica identified worrisome declines in the quality and efficiency of education, particularly in disadvantaged areas, due in large part to enormous growth in school enrollments, inadequate funding as a result of an economic downturn, and weak planning and administration. Low test results at both primary and secondary levels, and the entrance of a high number of unqualified teachers to address the growth in enrollment spurred a national reform in education. The reform included national standardized tests to identify deficiencies and reorient policies, the creation of the National Didactics Center (CENADI) to support in-service training, and of scientific high schools, and the founding of the Costa Rican Computers in Education Program.

Costa Rica has undertaken several initiatives to improve the quality and efficiency of basic education and to provide equitable access to educational resources for those currently underserved. It has also tried to increase the relevance of education to Costa Rica’s emerging labor market requirements and competitive position in the international economy. While the government has launched important programs in recent years, measures to improve educational quality have been slow to take effect. This is demonstrated by the relatively low average scores attained by 6th graders on a national assessment of math and verbal skills conducted in 1994 and poor results attained by 3rd, 6th and 9th graders in other diagnostic tests. However, in 1997, the National Testing Center identified a reversal of that trend. There has been an increase in access to secondary education in recent years, particularly in rural areas through the creation of 76 new high schools. In 1997 one year of preschool education became obligatory so that all children enter primary school on a relatively level playing field. Costa Rica has also introduced bilingual education to 1 of every 3 elementary school children, strengthened technical education and supported the expansion and consolidation of computers in education programs in both primary and secondary education. In 1997, the Costa Rican Congress passed a constitutional reform mandating that 6 percent of GDP be devoted to education.

II. STUDY METHODOLOGY

Levels of Analysis. This qualitative evaluation uses a case study approach carried out at three levels of analysis: country, school and classroom. At the country level, the study compares Chile’s and Costa Rica’s experiences in developing, introducing and maintaining their school-based technology initiatives. At this level, each country team explored its own experi-
ence by comparing it with the other’s analysis, with the intention that this exchange could be mutually beneficial and illustrative for other countries interested in formulating their technology in education projects.

At the second level of analysis, the study focused on 11 schools (5 from Costa Rica and 6 from Chile) serving middle to low-income students and deemed successful by field-based technology program staff. Data were gathered in both school and community contexts on the characteristics, perceptions and opinions of individuals regarding the technology program. Additionally, in each sampled school, two classrooms were observed, one where computer-based technology was being used and another where it was not. In the technology-using classrooms, the observations focused on recording the specific applications of the technology, the interactions among students and between teachers and students, and the pedagogical methods used when applying the technology. The non-technology-using classrooms were included to understand how the pedagogical methods and interpersonal dynamics in these settings differ from those observed in the technology-using classrooms, and to assess whether and how the introduction of computer programs in a specific classroom or laboratory influences the overall teaching and learning environment in the school.

**Research Team.** The study is the collective product of an international team of researchers and program staff based at the Omar Dengo Foundation in Costa Rica, the University of La Frontera in Chile, SRI International in the United States and the World Bank.

The country teams in Costa Rica and Chile conducted qualitative evaluations of their respective programs using the methodological framework developed by the entire multinational team. While acknowledging the risk of bias inherent in recruiting staff to conduct evaluations of their own programs, the research project recognized the advantage of giving program staff in both Chile and Costa the opportunity to reflect on their own experiences through participatory research and to compare these experiences to another country's by using a common research methodology. Although both programs had previously conducted internal research on their activities, this is the first opportunity they have had to do cross-national research. However, due to limited funds, the country researchers did not participate in site visits to each other's countries.

**Data Collection Instruments.** Interview and classroom observation instruments were developed by the international research team to ensure comparability between the Chilean and Costa Rican data. In addition, a detailed history of each country's technology program was gathered.

School principals, teachers, and computer technology tutors and coordinators were interviewed in each selected Chilean and Costa Rican school. These semi-structured interviews were used to gather data on the individuals’ professional and technological backgrounds, their management and/or teaching style, their attitude toward their role in the school, their relationship with the technology program, and their perception of the program’s impact on the school.

Finally, structured observations using specific guides were carried out in classrooms and laboratories where computer-based technology is being used, as well as in non-computer using classrooms. These observations were applied to characterize the learning environment and teaching and learning dynamic in each setting.

**Sample Selection.** Sample schools are all public or private subsidized schools selected because of their reputed success with computers and their orientation serving middle to lower-income communities. A procedure for establishing the selection criteria for successful schools was agreed upon by the international team and applied by program staff in each country. To de-
<table>
<thead>
<tr>
<th>School Characteristics</th>
<th>Costa Rica</th>
<th>Chile</th>
</tr>
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<tbody>
<tr>
<td>Student enrollment</td>
<td>1,080 - 1,604</td>
<td>400 - 1,100</td>
</tr>
<tr>
<td>Student-teacher ratio</td>
<td>23 – 33</td>
<td>16 – 27</td>
</tr>
<tr>
<td>Student-computer ratio</td>
<td>53 – 73</td>
<td>68 – 137</td>
</tr>
<tr>
<td>Principal software applications</td>
<td>e-mail; <em>LogoWriter</em></td>
<td><em>KidPix, ClarisWorks, La Plaza, e-mail</em></td>
</tr>
<tr>
<td>Availability of computers</td>
<td>18-20 computers per school placed in one lab</td>
<td>5-9 computers per school placed in labs and some classrooms</td>
</tr>
<tr>
<td>Person responsible for computers in the school</td>
<td>2-3 tutors</td>
<td>1-3 coordinators</td>
</tr>
<tr>
<td>Socio-economic status of students</td>
<td>low to lower-middle</td>
<td>low</td>
</tr>
<tr>
<td>School locations</td>
<td>urban, marginal-urban, rural</td>
<td>urban, marginal-urban</td>
</tr>
<tr>
<td>Community access to the technology</td>
<td>in all 5 schools</td>
<td>1 school of 6</td>
</tr>
<tr>
<td>Integration of technology applications and curriculum</td>
<td>not a program priority</td>
<td>high priority</td>
</tr>
<tr>
<td>Years in technology program</td>
<td>5 – 8</td>
<td>2.5 – 4</td>
</tr>
<tr>
<td>Grades with access to technology program</td>
<td>pre-school to sixth</td>
<td>pre-school to eighth</td>
</tr>
<tr>
<td>% of students in each grade with access to technology program</td>
<td>100 percent</td>
<td>Variable</td>
</tr>
<tr>
<td>Technology targeted to special education students</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1. Data on sampled schools in the research project, 1996

terminate the selection criteria in each country, a questionnaire was distributed to computer technology trainers, asking them to point out which of the schools under their supervision they considered most successful and to identify the specific characteristics of the schools leading to this conclusion. This short mail survey yielded the following criteria for a school’s successful adoption of each country’s technology program:

- Both countries:
  - a perception of technology contributing to a dynamic learning environment
  - a perception of technology enhancing students’ performance
  - active participation in technology training

In Costa Rica:
- a high degree of involvement of the local community in technology-related activities
- a minimum of 800 students using the laboratory

In Chile:
- a diversity of technology-based projects
- non-traditional teaching methods in technology-using and non-technology using classrooms alike
- a high proportion of teachers using the technology
- teamwork between teachers, computer coordinators and principals

Finally, each sample school had to have a minimum of 2 years’ experience using technology and had to serve middle to low-income students. However, as the results of the evaluation will show, the sampled schools do not necessarily reflect all of these characteristics. Table 1 provides summary data for the case-study schools in each country.

**Stages of the Research.** The research was carried out from March 1996 to March 1998 by teams based at Costa Rica’s Omar Dengo Foundation, Chile’s *Enlaces* program, the World Bank and SRI International. Michael Potashnik, from the World Bank, formulated the research proposal with the assistance of Barbara Means, from SRI International. Funding for the research came from the World Bank’s Research Program and its Latin America and Caribbean Human and Social...
Development Group. The project was launched in March 1996 at a workshop in San José, Costa Rica, where the entire research team refined the goals, methodology and work program for the investigation and developed common sampling strategies, data collection instruments and approaches to data analysis. Each country team then selected the case study schools, refined the data collection instruments, and pilot tested the instruments in one school.

A second workshop was held in June 1996 in Washington, D.C. to review the results of the pilot tests, confirm the effectiveness of the methodology, revise the evaluation instruments and develop a common format for the school debriefing reports. Fieldwork was carried out from July to November 1996, and a final workshop was held in May 1997 to present drafts country reports, to review research findings, and to develop overarching lessons.

The summary report was drafted by researchers from SRI and the World Bank and sent to the country teams for review and comments. Following the receipt of comments from the teams, the World Bank research team visited Costa Rica from March 9-13, 1998 to draft the final report in collaboration with the Executive Director of the ODF and members of the Costa Rican research team.

There are three final products of the research. First, each country team produced a country report oriented to a national policy-making audience, reflecting the main findings from their own analysis of the school-based case studies in their own country. These country reports summarize each national team's observations and findings from the field research. This summary document reflects the input of the entire research team and provides a comparative analysis of the results from each country.

III. PROGRAM DESIGN AND IMPLEMENTATION

Both Chile and Costa Rica have fielded long-term, large-scale sustainable, successful national programs supporting the application of technology in education. Both projects began with a pedagogical vision and a clear articulation of goals for teacher professional development and for technology use. However, Chile and Costa Rica approached the introduction of computers into their education systems in quite different ways, with regard to both the sources of support and to the strategies used to introduce computers into the schools.

Strategies at the National Level

Program Design. There are three main features of the Enlaces program's design and implementation strategy. The first is the decentralized cluster approach introduced when the program began as a pilot project. Under this approach, a university serves as the nucleus supporting a cluster of primary or secondary schools that are linked to one another through a wide area network. The university provides training to the schools in the use of computers, and assistance in selecting and using software specific to the school-based project that each school must develop in order to participate in Enlaces. This requirement is the second main feature of the Chilean program and gives it a distinctive, demand-driven characteristic since no school can participate without having developed a plan for how it intends to use the technology. Finally, in Chile a minimum of 20 regular classroom teachers and the school principal must endorse the program and participate in the training elaborated by their corresponding university. These features have resulted in tremendous het-

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1 Participants from SRI International, the World Bank, and the Omar Dengo Foundation attended this workshop. Chile's team was unable to attend, but provided comments through e-mail and telephone.

2 Before 1995, Enlaces has required that a minimum of 12 teachers per school endorse the technology program; the new minimum requirement reflects the growth in the availability of computers in program schools.
The Costa Rican program’s strong pedagogical orientation has been accompanied by a focused implementation strategy spearheaded by the Omar Dengo Foundation in collaboration with the Ministry of Education. In contrast to Chile’s demand-driven approach, in Costa Rica the Ministry of Education and the Omar Dengo Foundation select schools from across the country based on agreed-upon criteria, which include among others, school and community interest and explicit collaboration, willingness of teachers to be trained to become a part of the program, and equitable geographic and socio-economic distribution. The Omar Dengo Foundation and the Ministry of Education work jointly to train the key staff and define the program’s orientation, including the software and methodology for its application. Another difference is that whereas the Chilean program began as a pilot, the Costa Rican program has always held national coverage as a key component to its goal of having a “meaningful impact on the country’s socio-economic development” by bridging gaps across nations, generations and income groups (Fonseca, 1993).

The Omar Dengo Foundation and the Ministry of Public Education jointly chose a general pedagogical orientation akin to the program’s objectives and selected LogoWriter as the principal tool and environment for the program. The selection of a Logo-based application was meant to provide new opportunities to build children’s cognitive skills throughout his or her primary school years and to encourage students and teachers to enact greater control over their own learning. The lab tutors are directly responsible for the specific pedagogical materialization of the project and for the choice of specific areas of work for the lab activities. The number of teachers trained is defined not depending of the number of teachers per school, but depending on the number children and the number of groups that will require the services. Due to the importance given to philosophy and methodology, the 2-3 teachers from each school are continuously trained as teams, and initial training frequently includes the principal.

In sum, both countries’ programs emphasize equitable access to technology across income groups, both require teachers to engage in technology-specific training as a pre-requisite to introducing the program, and both work with existing teachers in the schools selected for the technology program as a strategy for securing collaboration from the participating schools and for keeping down recurrent costs in the educational system as a whole. However, the theories and strategies guiding each program are quite distinct. The Costa Rican program explicitly promotes constructivism through a single type of computer use as the favored pedagogical approach, whereas Chile’s decentralized model calls upon schools and the universities which provide them technical support, to define the content and direction of the program as part of implementing their own school-based projects.

Private Sector Support and Involvement. In both Chile and Costa Rica, the private sector’s involvement has been critical. Chile’s University of La Frontera and Costa Rica’s Omar Dengo Foundation have served as the driving forces behind the design and implementation of their respective programs. Another striking feature of both programs is the absence of central control from the ministries of education. Although in both countries the programs receive support from the ministries of education, in neither country has the government become involved in the daily administration of the technology program. Instead this role has been left to these private sector institutions in direct collaboration with the schools. This autonomy has isolated the programs from the political and financial cycles often associated with public sector programs, and each institution’s strong reputation has contributed to its
ability to attract leading academics and education professionals as program collaborators and promoters.

Both programs have also benefited from technical support from private firms in the technology field and national and foreign universities with established engineering and education departments. In Costa Rica, IBM won an international bid to assist in developing an integral approach to both the technical and educational aspects of the program. The idea behind the bid which was supported by Seymour Papert and other members of MIT’s Media Lab, was to draft a national program building on existing international experience and research. However, once the program was launched in 1988, Costa Rica developed its own national teaching and learning facilities and implemented the project with the support of Ministry of Education, University of Costa Rica and Omar Dengo Foundation personnel. After the contact with IBM finished, Costa Rica maintained its links with Seymour Papert and the Omar Dengo Foundation has made him its main advisor and an honorary member of the institution.

The Chilean program technical support was provided primarily by engineering school faculty from the Catholic University in Santiago who moved to the University of La Frontera in 1993 to help implement the Enlaces program. Additionally, Apple Computer provided informal technical support in planning teacher training strategies and selecting software. On several occasions, Enlaces technicians visited Apple’s headquarters in California 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 staff shared their experience with the Apple Classrooms of Tomorrow (ACOT) and donated computer equipment and software to Enlaces for evaluation purposes. In 1995, Apple’s ACOT program selected an Enlaces staff member, who is writing a book on Enlaces, to receive its first Innovative Scholars Award. This award supported a seven-month residency at the ACOT Center in California and provided a rich exchange of information and ideas.

Beyond the support provided by these various organizations at the national level, the involvement of the private sector has been key to implementation at the local level. In both countries, parents and other private individuals or locally-based companies have provided telephone lines, air conditioning and other equipment free of charge to the schools. Additionally, schools often use their technological resources to reach out to the community through adult computer education classes and the electronic production of newsletters.

**Stability and Support.** Consistent factors in both projects have been long-term stability and consistent and extensive resources. In addition, both projects began with a statement of goals supported by an explicit pedagogical vision.

The U.S. Agency for International Development (USAID) provided the seed capital for launching the project as well as an endowment which generates revenue for the ODF’s annual operations. Over the years, additional support has been provided by international agencies such as the United Nations Development Programme, the Inter-American Development Bank (IDB), as well as many local and community sources. The IDB financed the creation of academic degree programs in educational computing for program staff, the development of new learning environments, the project’s telecommunications network and impact evaluation studies. In addition to providing the financial support, the Omar Dengo Foundation has also supervised the project on a day-to-day basis through several changes in government. The consistency provided by the Omar Dengo Foundation has given the program a sense of stability unusual among innovative efforts in developing countries.

Chile also has benefited from stability and adequate financial support. There has been a stable de-
cratic government since the project’s inception; a large number of political leaders have supported the project, and the World Bank has supplemented government funds available for the effort. The project director of the government’s overall school reform effort, under which the computer activities have been placed, has remained constant since the project’s inception.

Applying Technology in the Schools: Participants and their Roles

The two countries’ implementation strategies for working with the participating schools are quite different. Costa Rica’s approach vests considerable responsibility with the tutor or tutors — those responsible for program management and laboratory instruction in the school — and, through annual training and site visits from regional advisors, provides the tutors with direct links to the Omar Dengo Foundation and the Ministry of Education. In the more decentralized Chilean approach, Enlaces uses its network of universities to provide a group of staff at each school with two years of training and technical support which is intended to make the schools reasonably self sufficient. Thus, after the initial two-year period of involvement with a school, the Enlaces program leaves the school to fend for itself and moves on to help others.

School Principals. Despite the fact that none of the school principals interviewed in either country had had previous experience with computers, they were all key proponents of the technology program and important to its successful implementation in the schools. The crucial factor in all cases was the open-mindedness of the principals regarding the technology and their ability to successfully foster the adoption and development of the program within their schools.

However, Chile and Costa Rica present an interesting contrast regarding the role of principals as users of the technology. In Chile, all of the principals interviewed use the technology as a tool in carrying out their administrative duties, whereas in Costa Rica none of the principals interviewed use the computers in the labs, either for administrative tasks or other applications. This difference partially reflects the specific orientation of each country’s program: the Enlaces program is promoted as a tool for the use by the entire school community to be applied toward a common goal articulated by the school community itself as well as more broadly within a school’s overall work program; in Costa Rica the computers in the labs are a critical input in a specific pedagogical process centered on students and tutors mobilizing their own creative energies. Correspondingly, in the Costa Rican Computers in Education Program, principals are trained in the pedagogical, not administrative, applications of the computer.

Teachers. In both countries, implementation of the technology program has introduced new roles for teachers including creating new positions to support the program. However, the different strategies employed reveal interesting contrasts between the two countries.

In Costa Rica, teachers wishing to become tutors participate in a selection process organized by the Omar Dengo Foundation. Once selected, they derive the benefits of a systemic training process and receive a 30 percent or 50 percent salary supplement from the Ministry of Education for the extra time they work at the computer lab before or after their regular teaching assignment. The number of tutors per school depends on the total number of students, and classes in each school, with schools usually training 2-3 tutors. Individually, or in groups, tutors are responsible for defining the educational activities organized for each group of students. Tutors are responsible for coordinating the use of the school’s computer resources and are directly responsible for working with students while they are in the computer laboratories; the regular classroom teachers, on the other hand, even when present in the laboratory, usually do not use the technology,
although they may have provided some input concerning the nature and content of the project their students work on at the lab.

In Chile, the Enlaces program designers’ goal is to have many of the schools’ teachers participate in the technology program and to use the technology in the context of the school’s overall work program. This is the objective behind requiring that a minimum of twenty teachers participate in the development and implementation of each school’s technology project. In addition, each school participating in Enlaces is required to appoint one to three teachers to serve as the school’s technology coordinators. The coordinators provide technical and administrative support to their fellow teachers and the principal. They are responsible for scheduling the use of computers, maintaining the equipment, securing the necessary materials for the implementation of the school’s technology-based program, training teachers and students, and encouraging their fellow teachers to use computers in teaching basic subjects. In contrast to the advisors in Costa Rica, who provide training and support to school staff, these coordinators are based at the school and their work as coordinators must be assumed by the school while meeting its other basic obligations. The amount of time devoted to the job of coordinator varies considerably across schools, from a few hours a week to a full-time job. Furthermore, whereas in Costa Rica the Ministry of Education provides a financial supplement to school-based tutors, in Chile payments to the technology coordinators are up to the school. Finally, in Chile there are no new positions funded by the government, whereas in Costa Rica, the government funds a network of technology advisors.

Costa Rica’s Advisors. Costa Rica has established a system of advisors that are responsible for providing training and on-going support to tutors, school staff and educational authorities. Many of them work at the regional level and have responsibility for approximately seven schools; they act as link between the tutors and the program, and work on maintaining coherence between what takes place at the lab and the general objectives and activities of the program. In this respect their role is relatively similar to that played by the university-based staff working with their corresponding Enlaces school. Their responsibility is to design and provide training, pedagogical assistance, guidance and feedback to laboratory tutors and their students. They provide the schools in the program with a direct link to the Omar Dengo Foundation and meet once a week at ODF to receive training, share experiences, engage in research and follow-up on specific issues. Although their salaries are paid by the Ministry of Education, their programmatic orientation and training comes from the joint Omar Dengo Foundation-Ministry of Education program.

Program Training

Both programs emphasize the preparation of school-based staff for using the technology as intended and devote considerable resources to training to ensure each program’s intended results.

Training in Costa Rica. In Costa Rica, training is aimed at the advisors, laboratory tutors and, to a lesser extent, school principals and staff. Every year, advisors are required to attend a two-week, 80 hour course given by the Omar Dengo Foundation and the Ministry of Education. This training conveys the main theoretical and pedagogical facets of the program so that the advisors can in turn pass this information on to the laboratory tutors. Advisors also are required to attend several courses during the year on a range of subjects from pedagogy to technology, and have the opportunity to attend a variety of specialized courses both nationally and internationally, some of which can be quite extensive. Finally, workshops of varying length emphasizing Logo programming and other technology applications are offered on a demand-driven basis throughout the year.
The training program for laboratory tutors begins with a series of basic foundation courses lasting three weeks (120 hours), offered by a group of professionals, most of them program advisors, from the Omar Dengo Foundation and the Ministry of Education. For accreditation, tutors are required to attend a minimum of 102 hours. Existing tutors are required to annually attend the two week, 80 hour, training session each January focused on reinforcing and enhancing the theory and practice employed in the program that is also given to the advisors. Additionally, tutors must attend sixteen hours of workshops each year, given by the advisors. Finally, tutors are provided pedagogical and technical advice on an ongoing basis by advisors and have the opportunity to obtain degrees in educational computing, which were designed with ODF assistance and are offered at Costa Rica’s National University for Distance Education (UNED).

At the beginning of each school year, principals, teachers and interested individuals are invited to a day-long presentation to familiarize them with the aims of the technology program and the Logo software. Additionally, interested staff are invited to attend a week-long course on the objectives of the program and the use of computers for basic functions such as word-processing and spreadsheet functions. In all of these activities, the Costa Rica program emphasizes training in constructivist pedagogical theory and methods and the teacher’s role as a facilitator in the student’s pedagogical development through the use of Logo in the laboratory.

In alternating years, Costa Rica holds two conferences: the Children’s Logo Conference and the Advisors and Tutors Conference. At the Children’s Logo Conference, approximately 400 children are invited to display the results of their laboratory work in a new learning environment which involves using the computer to carry out research on themes such as the environment and Costa Rican history. Each school nominates a boy and a girl to present the school’s work at the bi-annual conference. The Advisors and Tutors Conference provides an additional opportunity for teachers to share experiences and develop professional awareness.

In sum, the close networking by the advisors, the intensive recurrent specialized training for laboratory tutors, the national conferences and the consistent pedagogical orientation promoted by the Costa Rican program have given the participants a strong sense of mission. However, these same characteristics, and particularly the limited training for principals and classroom teachers, have restricted the latter group’s exposure to the program and this issue has emerged as one of the major challenges facing the Costa Rican program today.

Training in Chile. The Enlaces training program is shorter than the training provided in Costa Rica, but includes more people per participating school. The Enlaces training program is aimed at supporting the expansion of the program to new schools; consequently, the majority of resources are focused on training new teachers. When a school joins Enlaces, initial training is provided for the twenty or more teachers and the principal who developed the technology project. The training is provided over the course of two years, with the first year focused on familiarizing the staff with the selected hardware and software. The first year of training takes place in the school in order to reach as many teachers as possible. In the second year, the training is focused on using the computers to support specific classroom activities and administrative work. When Enlaces was first introduced, this training was quite basic and aimed to familiarize the staff with the computers and to introduce them to the locally-developed software program, La Plaza (described below) and the use of its research and networking functions. Beyond this basic training, which was imparted in six two-hour sessions, specific content was linked to the school’s own goals as reflected in each school’s project. Both the training and strate-
gies on how to implement the program are developed in conjunction with the local university appointed as the school’s nucleus. In Chile, there are many cases of teachers taking full advantage of the open-ended nature of the training opportunities.

The teachers selected as school-based coordinators receive additional training in technical issues in order to strengthen their position as the promoters of the effective use of computers within the school and trouble shooters for the program.

Since 1996, each of the 26 universities serving as a nucleus for the Enlaces schools had the freedom to implement its own courses and develop its own material, however, many of the smaller universities decide to replicate the training material and strategies designed by the University of Frontera. In addition, the University of Frontera gives technical training to faculty associated with the Enlaces program at the nucleus universities.

Enlaces’ two year training plan seeks to ensure that school staff are able to effectively use the software and hardware provided. If this has not been accomplished after two years, additional training is provided until these minimum requirements are met.

The Distribution of Technology in Schools

Hardware. The majority of the laboratories in Costa Rica have 20 networked computers and a dot matrix printer. Each laboratory is also connected to a modem to facilitate access to the Educational Telecommunications Network. Although school size varies, the number of computers per school is based on the average class size in the school in order to ensure that the majority of children have access to the computer at least 80 minutes a week. This equipment is provided by the Omar Dengo Foundation. For its part, any school participating in the program must work with the community which it serves to provide a room dedicated for exclusive use as a laboratory, complete with air conditioning, furniture, proper illumination and a way of securing the computers.

In Chile, the per-school allocation of technology resources is based on student enrollment. Schools with less than 100 students receive three computers, a modem, a CD-ROM player and a dot matrix printer. Schools with 100-300 students receive 6 computers and the same number of peripherals as the smaller schools, while large schools with over 300 students receive 9 computers, 2 CD-ROM players and the same number of peripherals. In Chile, the location of the technology resources within the school is not specified, although Enlaces requires the school to create or re-allocate space for the computers. Schools have resorted to a variety of solutions, including setting up computer rooms or installing the terminals in the library. In several of the sampled schools, computers were set up on mobile carts, allowing them to be moved from classroom to classroom. Additionally, Enlaces recommends that one of the school’s computers be dedicated exclusively to the teachers and located in an area separate from the students’ computers in order to give the teachers the opportunity to work with the technology without being scrutinized by their pupils.

All of the sampled schools in Chile had experienced growth in the number of computers available since their initial contact with Enlaces, provided either by Enlaces or by the community. However, despite this growth, the number of computers available to students in Chile remains limited, with an average of 68 to 137 students per computers in the sampled schools. This ratio is well below that observed in the Costa Rican sampled schools where the ratio of students to computers is 53-73 to 1.

Software. All Enlaces schools use the La Plaza communications software, which was specifically designed for the technology program and consists of a user-friendly graphic interface representing a town’s
main square. In the main square, an icon represented by a post office represents access to electronic mail; a museum icon provides information and reference material; the cultural center's bulletin board serves as a chat room; and the kiosk posts school and community news. Beyond La Plaza and a strong emphasis on networking, software packages and specific training have varied greatly across schools and over time — an outcome that is consistent with the individual, school-based approach. As a result of this open and evolutionary approach, Enlaces has never developed a software “model”. Instead, schools use a mix of international and local software such as KidPix, ClarisWorks and Carmen San Diego as well as software developed especially for exploring national cultural issues in Chilean schools such as Chilean Artists and Chilean Aborighines.

In Costa Rica, _LogoWriter_, a 1988 Spanish version of _Logo_ which includes word processing capabilities, is the principal software program used in the schools. _Logo_ was selected as a learning medium for both teachers and students. This focus introduced high demands since it made it necessary to train teachers and tutors in _Logo_ as a programming language and to introduce an educational philosophy and constructivist practice associated with the use of that programming language. Besides _Logo_, the Costa Rican program has provided schools with a computer network administrator, Microsoft Works, and telecommunications software. The telecommunications software allows for the use of e-mail within the ODF’s Educational Telecommunications Network, through which schools produce and share projects, including an electronic magazine which students produce three times a year.

Costa Rica chose _Logo_ for two main reasons. Through the use of _Logo_ it could encourage children and teachers to generate their own projects and software and not simply become passive users of programs produced by others. Second, _Logo_ serves as a generic learning medium that does not demand constant investment in upgrading or the purchase of a variety of software packages to support various curricular applications, which is a real concern for projects of this type in developing countries with limited resources.

IV. FINDINGS

This section describes the research findings observed in the sampled schools in terms of changes in teachers' and students' roles; project implementation in the schools; impact on students' motivation and self-esteem; evidence of student learning; impact on teachers' self-esteem, collaboration and development; and impact on school relations with the community. The results draw directly from the data collected in the schools; all quotes are direct citations of informants' comments, as transcribed in the field interviews, and all boxes describe classrooms or laboratories observed in the sampled schools.

The results described below are drawn from a small, non-random sample of schools selected for their reported success with technology programs. While the findings are useful for obtaining insights into successful implementation strategies and illustrate the challenges faced in introducing technology into schools, the descriptions should not be interpreted as representative of either the Chilean or Costa Rican school experiences as a whole.

1. The Changing Roles and Learning Styles of Students

Student Collaboration using Computers. Both programs have students working at computers in pairs or in small groups. In Costa Rica, this practice reflects a philosophical commitment to collaboration while in Chile, teachers regard it as a matter of expediency, given the limited supply of computers. In both countries, the interaction observed among students varies from frequent juxtaposition (control of one student over the other) to cooperation, which is understood as joint
Box 1. Student Collaboration in a Costa Rican Computer Lab

In one observed laboratory session in Costa Rica, a pair of students was using Logo to manipulate four separate figures in an attempt to fit all four figures into specific positions on the computer screen. This pair was encountering difficulty in accomplishing their chosen task. When a solution suggested by the tutor proved ineffective, a fellow student from another pair who had been observing the first pair’s program came over to suggest an effective solution. This was done in a respectful manner, by first whispering the solution to the tutor, who, instead of giving the correct solution herself, responded “listen to what Rodolfo has to say” thereby encouraging the pair having trouble to work directly with the student who had found a solution to their programming problem.

and interactive planning to solve problems and meet challenges. In two of the schools in Costa Rica, observers noted that the majority of student pairs worked in true cooperative fashion—alternating control of the keyboard and discussing their goals and reviewing their programs together. The forms of interaction are related to the way in which the tutor orients the classroom. It is worth pointing out that neither the Chilean nor the Costa Rican program provides specific policies for generating student cooperation.

Working in Groups. Research observations of students in the Chilean and Costa Rican computer labs revealed stark contrasts to the conventional, non-technology-based classrooms where lecture and recitation continue to be the norm. One Chilean teacher characterized this traditional approach as the “neck culture” where each student stares at the neck of the student in the next row up. The country evaluators found that student-teacher relationships within the computer labs were more personal and that students were less fearful and showed greater independence than in more traditional classrooms. Expressing an observation shared across both countries, the Costa Rican team described children in the computer laboratories as “noisy, boisterous and spontaneous yet respectful”, thus showing a relaxed and enthusiastic attitude when at work. The positive attitude of students and the openness of tutors to this type of approach is illustrated in Box 1.

In two-thirds of the Enlaces case study schools, the evaluation team concluded that computers had increased the likelihood of students working in cooperative groups in traditional classes. One principal reported how this tendency toward collaboration grew out of the need to share computer resources:

“... if a class has 25 students and there are only three computers, it is necessary to find a way to make the number of groups equivalent to the number of computers; this led naturally to a change in classroom organization and to children forming groups and being more friendly.”

In both countries, the national evaluation teams recognized the increased collaboration among students as positive and significant given the ongoing presence of more traditional, directive teaching in the majority of classrooms in the country.

Serving as Student Computer Assistants. The Chilean computer program has encouraged schools to appoint older students with a special interest in computers as “monitores” or computer assistants. These assistants are assigned various tasks by the lab coordinators, and often carry out additional projects at their own initiative. The main task of the student computer assistants observed was to help other students in using the computers and the software in the labs and classrooms. The research team in Chile found that all
Box 2 Student Computer Assistants in a Chilean School Support a Natural Science Lesson in the Computer Lab

In this school, a teacher had divided her class into two groups, sending one group of 12 students to the lab to work with student assistants, while the remaining 27, who would go to the lab the following week stayed behind in the classroom.

The observer describes how the session is organized: “The session begins in the classroom, the teacher names the students who are going to the computer lab this week and accompanies them to the lab. In the lab she explains the assignment to the student computer assistants and the other students, reminds the students that the student computer assistants are going to be in charge and that she has asked them to help out on specific tasks of the assignment. After giving instruction, the teacher returns to her classroom, returning to the lab two times to oversee the student work. The activity in the lab consists of each student graphing their pulse rate in three different situations (seated, jogging, and running), using data they had gathered previously and brought to the lab in their notebooks. For this activity, the students use the educational software “The Graph Maker”... “The children organize themselves into pairs to work together on one computer, but each is to prepare his own graph.”

The observer notes that the 6th grade computer assistant shows the best command of the technology and the software and all the students turn to him most often for explanations on how to make the graph. “This monitor teaches the children how to use the program [it is the first time they are using it], he approaches each pair and explains how they should enter the data, where they should note down the variables, shows them different ways of making graphs, and what they have to do to get the graph on their screens. After making these explanations, the monitor leaves the students to work alone, and during the lesson responds to questions, showing the answer or how to execute the operation, and at times too fast for the students to understand.”

The observer notes that there is a lot of noise in the lab while the students are doing their assignment, at times all the groups yell out for help. However, the student monitor is of good disposition and works well with the students. He is fast and efficient. “Several students learn to use the program through trial and error, the rest depend on the help of the monitors.” When the teacher visits the class during the lesson, she reviews the students’ work, asking why they chose a particular graph and reinforcing the lesson.

sample schools had introduced the use of monitors and were using them quite effectively. For example, at one school, a teacher was observed using three student computer assistants (one from the sixth grade and two from the eighth) in conducting a class in the lab on the circulatory system for a natural science course. (Box 2).

Observations at other schools showed that student computer assistants worked alongside lab coordinators in preparing computers for student use, answering student questions during lessons, and working directly with some students needing more help.

2. Impact on Student Motivation, Behavior and Self-esteem

In both countries, teachers and principals report that computer use in the schools has had a positive impact on several aspects of student attitudes and behavior. Anecdotal data show that students were more motivated to come to school, more excited about learning and better behaved after the introduction of technology.

Affective Impact. Both evaluation teams obtained strong, positive reports concerning the programs’ influence on student motivation and self-esteem. In each country, numerous positive effects on self-concept, aspirations, behavior, and persistence were reported. In Costa Rica, school staff reported positive effects on
self-esteem and students' "excitement to learn." Chilean principals and teachers described students as having a greater interest in their school work, taking more responsibility for their work, and having a stronger will to improve their work, after exposure to technology. At one of the Chilean schools it was noted that students were coming to school during their off-hours to use the technology; and at two of the Costa Rican sites children came to the lab during free periods.

One Chilean principal asserted that the program had increased students' motivation to stay in school:

"They are more responsible, less aggressive and have a greater interest in work. Assignments used to require a lot of work for teachers because children did not assume any responsibility or try to meet work demands. Right now, all of this has improved. For instance, the research work they are submitting is impressive, they wish to improve; we have also noted that there is greater interest in continuing in school, not dropping out after the eighth grade and why, because they leave this school and they seek a school where they can continue learning computer science; this has been quite noticeable."

The increased desire to remain in school appears to be linked not only to greater enjoyment of school activities but also to a higher level of aspiration. A Costa Rican school principal reflected:

"...they [the students] have been encouraged to be computer professionals in the future. Children from a community as poor as this, you can imagine what it means to them. ...[for these children] it was an impossible dream to have a computer at home and the fact that these children have had the opportunity to learn computer science, this has really changed them."

The linkage between computer work and high motivation was further illuminated in one Chilean case study school that changed the way it used the computer lab during the course of the study. At first the school used its lab as a resource for regular classroom teachers to use with their students in working on their regular curriculum. Later, the school switched to using the lab to teach computer skills directly, decontextualized from the curriculum. In the latter case, the level of computer skills rose, but according to the study team, students appeared less interested in their computer work. This observation suggests that longer-term motivational benefits of technology may depend upon how it gets used with students.

Cumulative Impact. Several of the Costa Rican informants made the argument that technology experiences at an early age gave students increased self-confidence, which transferred to their behavior outside of the computer laboratory. One school director described second graders who had been in the program since kindergarten as "more mature, with less fear to be in front of the group making a presentation, to speak." A tutor at another school stated that "it [the computer experience] gives children self-confidence, the ability to make presentations and ease of expression."

In one of the Costa Rican schools, there was a fifth-grade class that did not participate in the technology program and one that did. The laboratory tutor reported seeing differences between the two groups:

"Children who come to the lab . . . are more ready to learn, learn faster, are more mature. They no longer fear the computer and they are not fearful of anything."

Discipline and Self Control. In Chile it was reported that contact with technology helped some students have overcome discipline problems. In a related vein, a laboratory facilitator from a Costa Rican school reported: 1

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1 Other research conducted by the Omar Dengo Foundation with the InterAmerican Development Bank has found evidence corroborating these findings regarding the technology program's positive impact on students' motivation and self esteem. Fundacion Omar Dengo, Banco InterAmerican de Desarrollo Projecto BID-FOD, "La Vivencia en el Laboratorio de Informatica Educativa del PIE: Un Acercamiento a los Procesos Generados en Ninos y Nina," Informe de Investigacion Evaluativa No. 2-95, April 1995.
reported benefits for students who otherwise exhibited behavior problems:

"The children who are most troublesome in the classroom, the most hyperactive, are the ones that enjoy it [the technology lab] most. The most beautiful projects belong to them, and I am happy to see how computers have helped these children."

3. Evidence of Student Learning

Teachers and principals in Chilean and Costa Rican schools generally share the perception that their computer programs are having a positive impact on students' learning, including for students with learning disabilities. The reported impacts on student learning generally fall into the areas of thinking skills and technical proficiency.

**Thinking skills.** Some of the teachers and principals interviewed believe that the use of computers enhanced students' thinking skills. For example, one school principal in Costa Rica reported:

"It [the technology program] has helped many children to develop their critical and rational abilities, encouraged children with great capabilities... and also encouraged those who are slow... from an intellectual viewpoint I believe this has been a tremendous help..."

A laboratory tutor from another school in Costa Rica reported that the computer lab work has made students more active learners. In Chile, a principal reported that the level of research students were doing with technology was "quite impressive." Another reported positive impacts on language skills and spelling.

One of the tutors from the Costa Rican labs reflected the philosophy underlying the strategy of extensive Logo use with young children:

"Children working with Logo... need to struc-

ture their thinking; they must reflect on what things to do first, how to do it; getting organized. Self-confidence is developing and the child must decide what to do — if I do it this way, this might happen; if I do it another way, there will be another reaction; how do I do it; and if the student made a poor choice, he/she knows that it can be corrected because there are other alternatives. Thus this changes the individual's life entirely; the student's thinking is structured in various ways... Later they will learn other packages which is "press a key and this comes up", but for that, they have enough time."

The Omar Dengo Foundation program staff cite this research and corroborating evidence from other studies regarding the ability of students to transfer what they learn in the Logo lab to life outside the school. One advisor referred to it as "a small lab representing life's realities" and predicted that students would later use what they learned in the lab, especially in making decisions.

**Standardized Test Scores.** The Chilean team examined standardized test performance for the schools in their case study sample. They did not observe any consistent trend over the period of involvement in Enlaces except for a single school, which had embarked upon a comprehensive school-change process and which showed steady improvement in its performance relative to other schools serving similar student bodies. The Costa Rican evaluation team did not look at standardized test scores because they felt that what these tests measure is not directly associated with the program objectives, and, given the great diversity of variables associated with results in standardized tests, it would be difficult to establish a serious correlation.

**Technology-Related Skills.** Costa Rican evalua-

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4 To celebrate the 10th anniversary of the ODF, former students of the program, wrote essays on how computers impacted on their lives. The ODF has plans to incorporate them in a future publication.
tors saw tangible evidence that some children were advancing in terms of their knowledge of Logo programming. In some of the schools, students had advanced from following specified procedures that were given to them, to developing long unitary procedures by trial and error, and finally to a point where they could plan and design general programs (super-procedures) comprised of subroutines. Especially because there was relatively little direct instruction on the use of the latter approach, the Costa Rican team saw the emergence of the more sophisticated programming strategy among some children as an important accomplishment because it signifies students’ capacity for planning and organizing their own work and for working effectively in teams.

Other evidence of learning of technology skills was the level of sophistication and creativity in some of the student-developed work. For example, projects that students from the case study schools presented at the 1997 Children’s Logo Conference included a sophisticated animation of Costa Rican swimmer Claudia Poll winning the gold medal at the 1996 Olympics. Other examples of complex programming processes generated by students in the study included a collection of Costa Rican provincial emblems created as a social studies project that was presented at the Conference.

In the Enlaces schools, only one school reported a high level of skill in technology use per se. In this school the greatest proficiency was reported for sixth-grade students who became computer “monitores” or assistants helping other students in the use of technology:

“The children were the ones that learned more [than the teachers]. Thus, the teacher was no longer the wise man . . . right now if the colleague has any doubt or any problem, he looks out for a kid from sixth C and David [a student monitor] goes out to help them and teach them.”

4. New Roles for Teachers

In both Costa Rica and Chile, computers were used in classes for children with learning and physical disabilities. In fact, one Chilean school chose a special education project for its submission to join Enlaces. The coordinator working in this school strongly endorsed the value of using computers with special education students. She noted that with technology

“the teacher can help these children with so many problems...there are other methods, but it [the computer] helps the special education class...they concentrate more, they are happier, they are working, they are doing things well, therefore, it helps the teacher provide something different to these students.”

In Costa Rica, one of the tutors working together with a classroom teacher concluded that the experience with computers proved very helpful in developing the self-esteem and abilities of slow learners:

“In 1995, I had five slow children. The regular classroom teacher and I wrote a profile for each student at the beginning and end of the school year. Three of the children demonstrated an increase in their self-esteem which helped them to adapt more effectively in the classroom since they could express themselves better ....”

4. New Roles for Teachers

In both countries, researchers found evidence that the technology programs influenced student and teacher roles — the ways that teachers and students view their responsibilities with regard to learning, the ways teachers interact with students, and the ways students interact with each other. The researchers found trends toward less explicit direction on the part of teachers, greater student initiative, and more collaboration among students — all similar to findings of studies conducted of the evolving roles of teachers and students in U.S. classrooms (Dwyer, Ringstaff, and Sandholtz, 1990; Means and Olson, 1995).
5. Changing Teaching Styles: Laboratories and Classrooms

The Chilean evaluation team reported greater changes in teacher behaviors in those schools that were among the most active participants in Enlaces. The teachers in these schools were less likely to lecture or use drill and practice, and were more likely to engage students in collaborative group work and to give students greater responsibility for planning and executing their own activities. The observers reported that these teachers were able to move fluidly between maintaining discipline and monitoring student work and attributed this to high student motivation. One Chilean principal described this evolution:

"The teacher's role has changed to one of providing guidance to the groups. It is sort of a consultant's role, advising on how the work is done and making suggestions when something is missing. The child then feels that he/she is creating and originating his/her own work and managing his/her knowledge, and this has changed the mentality of the children to be more responsible and to meet work demands on schedule."

One teacher who had been at the same case study school for 3 years described a preference for organizing her class into small groups so that students can profit from learning from each other. She believes that a warmer, more personal atmosphere is maintained with this small-group structure. She had never used computers before coming to this school, but had incorporated technology into her teaching by the time of the study. She believes that students learn easily with technology and that they should be given opportunities to explore and develop their research skills with computers:

"They learn almost intuitively [with technology], in the same way they learn games... True, one can guide them and explain, but they learn much more by navigating alone. Another thing, with the computer, I give them instructions only once and the child remembers. I rarely have to repeat things twice. We have to do it this way!"

Three of the five laboratory tutors observed in Costa Rica conducted their laboratory sessions in a fashion the researchers judged to be generally consistent with their training. For example, the tutors began by introducing the concepts underlying the programming task, the children engaged in the programming activities linked to those concepts, and then the children were encouraged to design their own programs using what they had learned. In interacting with students, the tutors strove to teach by responding to questions with questions that provided clues and helped the students visualize the problem in a useful way, rather than by providing a direct answer.

However, two of the lab tutors used a traditional, directive style of teaching. For example, when giving assignments, they had students copy all instructions, and sometimes even every programming step, into a notebook, after which students would have to input the programming commands into the computer. These tutors appeared to measure their success by their students' ability to achieve the specified effect on the computer screen, rather than by any indications of students' acquisition of thinking or generalizable programming skills. The fact that a didactic style of teaching persists in almost half of the laboratories, illustrates how difficult it is to fully implement a pedagogy radically different from the dominant form of instruction within a country.

In Costa Rica, three of the tutors who also teach regular classes were observed in their classrooms as well as the laboratory to see if the laboratory experience and training had any influence on their regular classroom practice. Although their approaches dif-

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5 Two of the five tutors in the sampled schools in Costa Rica did not teach outside of the laboratory and were therefore not observed in a traditional classroom setting.
Box 3: From Laboratory to Classroom: Preparing for Exams in Costa Rica

The teacher, who also works as a computer laboratory tutor, was observed in her regular classroom where she had distributed question-answer materials to her students to help them prepare for upcoming exams in Spanish, mathematics, science, and social studies. Rather than having students practice the materials independently with herself as grader, as one might expect, she broke the class up into small groups to coach each other on the questions. Groups were given considerable freedom of interaction. The teacher acted as a guide, responding when a group asked for clarification. In answering student questions, the teacher typically probed to prompt students' further thinking rather than providing a direct answer. In her interview, this teacher said that she had taken this discussion group format from her computer laboratory experience.

ferred, all showed some evidence that their training and experience carried over into their classrooms. For example, instead of having desks arranged in rows facing the teacher and blackboard as is traditionally found in Costa Rican schools, all three teachers had repositioned the student desks so that groups of students faced each other. Additionally, in one of these classrooms, the tutor used a student-centered, collaborative approach to preparing for a standardized test which is an interesting development considering the type of task and the traditional way of approaching it. (Box 3).

Though this type of change had been observed in schools participating in the program throughout the years, this was the first time that a research team documented research evidence in the regular classroom of the non-traditional style of teaching promoted in the technology laboratory. The team considered this evidence of penetration in the majority of the sampled schools to be one of the most important, positive findings of the research.

6. The Spread of Technology in Schools

In Chile, the research found that a higher proportion of staff in the sampled schools made direct use of the technology, as compared to the Costa Rican schools. This finding is consistent with Enlaces’ requirement that a minimum of 20 teachers and the principal develop a program and receive training and with the Enlaces program’s emphasis on promoting the use of technology throughout the teaching staff. In one case study school, in fact, all but one of the teachers had become technology users. This result may also be linked to the Enlaces strategy of designating at least one of the computers installed in schools for the exclusive use of the teachers and the principal. In the Chilean case study schools, teachers and administrators are using technology to produce instructional materials, examinations, bulletins, memoranda, and other documents that were once produced by hand. Principals at the case study schools, who were required to participate in Enlaces training during the first year of implementation at their schools, also have become technology users. This development is impressive given that none were users before the project.

In Chile, student access to computers varies across schools, with some limiting access to certain grades or students while others give access to all students. An estimate carried out as part of another study reveals that, with two students working on a computer, the existing Enlaces norms for the provision of computers would allow for all students in a school to have access to the computer for one hour per week in larger schools and two hours per week in smaller schools (Potashnik, 1996).

In the Costa Rican project, one of the central objectives was reaching the largest number of children
possible. As a result of this, more children per school have access to computers and for longer periods of time. At present over 30 percent of the primary school population has regular access to computers for an average of 80 minutes a week.

On the other hand, spread of the use of computers beyond the computer laboratory was never a goal in the Costa Rican project, and therefore it is not surprising that in the sampled schools teachers other than the laboratory tutors were not using the technology provided by the program. In fact, there was only one instance at the five sites where a teacher was seen to use a computer, and this was a case where the regular classroom teacher filled in as a partner for a “slow” student whose partner was absent. In Costa Rica, none of the principals interviewed used the lab computers for administrative or other applications, although principals receive training on the pedagogical use of computers as well as general orientation regarding its use. However, in three of the sample schools, non-program computers purchased by the school boards or directly by teachers were being used for school administration or personal productivity.

In the case of Costa Rican tutors and regular classroom teachers, the study also found less evidence of the use of program-provided computers for personal productivity, although several of the laboratory tutors did purchase computers for their own use. Therefore it is not surprising that teachers other than the laboratory tutors do not use the labs in the schools. In fact, there was only a single instance at the five sites where a teacher other than the lab tutor was seen to use a computer, and this was a case where the regular classroom teacher filled in as a partner for a “slow” student whose partner was absent, thus reflecting the occasional participation of the classroom teachers in instances in which their educational support is needed.

6. Teaching with Technology.

Enlaces was established with the goal of supporting a variety of curriculum activities, although the way in which this was to be done varied across schools since each school is given considerable leeway in developing its own computer-assisted project. Teachers in Chile reported that after receiving the training they felt obligated to use the technology in their teaching. Technology is being used to support a wide range of curriculum areas in the case study schools in Chile, particularly in Spanish language, social and natural sciences, with less use of the technology in mathematics.

In Chilean schools where technology appeared to be taking hold within the broader educational program, researchers found a shared vision for instructional use among a core group of teachers, including the teacher acting as the technology coordinator, and the principal. In some cases the coordinator played a key role, providing models for teachers suggesting how to use technology in specific curricular areas.

A Chilean teacher was observed teaching her fifth-grade Spanish class in the computer laboratory, as described in Box 4.

In two Chilean schools, the research team observed social and natural science classes being taught with software on Chilean geography and indigenous peoples, both developed locally. In an 8th grade geography class devoted to the study of natural resources, students were using library resources and the computers with the software “Geography of Chile” to study the distribution of natural resources in Chile. In another school, in the South of Chile, where there is a large indigenous Mapuche population, a second grade teacher used the software “Aborigines of Chile” to study the customs of three other indigenous people in the country.

In Costa Rica, teaching the core academic curriculum with the technology is not a program goal, rather the goal is to use computers to enhance teaching and learning through the development of educational projects associated with different curricular topics, especially in the core curriculum of math, language
Box 4. Using Technology in a Spanish Class in a Chilean School

This fifth-grade Spanish class was conducted in the computer laboratory where students were organized into groups of four, although not all groups had access to a computer. Using texts previously prepared by individual students in the regular classroom, the students began work on a group product. Students used a word processing program to write letters to students at other schools in the city with whom they were going to begin a communication project concerning regional literature. The teacher moved from group to group, correcting spelling, making suggestions about the writing, and resolving some technical difficulties. She asked those students who were not working with computers to lower their voices. As each group finished writing, the teacher printed two copies of their work, one for the wall newspaper and one for the group. This teacher used similar approaches in her regular classroom, including having students work in small groups.

In the case of Costa Rica, the use of a programming environment and the development of specific programming skills has an even more important teaching purpose, as stated by a tutor:

"children build their own knowledge... They do not receive finished products, they really learn while they are doing."

An advisor states this overriding goal more clearly when she says:

"I think the computer takes the child to that place we all have and makes him or her think, reflect, ask questions, know a different world... Being in constant interaction with it brings him or her problems, makes the child develop skills for decision making, autonomy, to decide whether or not to do something, whether or not to do it in a certain way. I think it is a small laboratory for what the child is going to face in his future life."

In none of the case study schools in either country did the evaluation find evidence of classes where computers were being used as the principal vehicle for the teaching of a core subject. As noted in the aforementioned examples, the use of technology in the schools observed in Chile remains focused on individual projects. One Chilean teacher explained that in
her school the limited availability of computers for teaching has discouraged teachers from using computers more intensively. In Costa Rica, although the research team found some evidence of core subject areas being explored in the computer laboratory, in none of the groups that were observed within sampled schools were teachers explicitly using the technology to support the teaching of core curriculum subjects.

Both Chile and Costa Rica have provided students with experience in the use of e-mail; and in some Chilean schools, with the use of the Internet. Since Enlaces is designed as a school network project and provides special communications software on all computers and a server, students and teachers have been encouraged to make use of this resource. In one of the case study schools in Chile, the research team observed a group of fifth and sixth grade students using the e-mail during their free time to correspond with students at another school. Whereas the teacher serving as the computer lab coordinator was available to work with the students, the students demonstrated considerable autonomy in carrying out their work as well as mastery of the mechanics of the technology. However, despite the active use of e-mail in the sampled schools in Chile, the use of the Internet as a resource remained limited.

The Costa Rican team found that the Educational Telecommunications Network Internet connection available in program schools was receiving minimal use within the computer laboratories. Factors that likely contributed to lack of use include that, at the time of the study, only one computer in each laboratory had network access; there were technical difficulties reported in using LogoWriter with the network; and tutors received little training in the use of the network. The evaluation team also concluded that articulation of clear program goals for the use of the network and policies for integrating it with the better-established routines for Logo use were needed. However, it is worthy of notice that even within this extremely limited telecommunications platform, three of the five schools studied participate in the edition of an electronic magazine which has a virtual editorial committee run by children.

8. Teachers' Professional Growth and Development

The technology programs, as observed in both countries, have enhanced the professional standing of teachers and promoted contact with other teachers and outside professionals. Changing roles and increased self-esteem reported by teachers are also by-products of participation in technology programs.

New Professional Relationships. In Costa Rica, teachers reported that their collaboration with the Omar Dengo Foundation has provided them with sustained contact and experience with national and international experts and educational ideas. The program has generated a true network of innovative teachers working throughout the country who communicate through e-mail and regularly participate in annual regional and national activities through which they exchange experiences and knowledge. The meaning of a professional network is summarized in the words of a advisor who says:

"What I really find fulfilling is to know that what I am doing here can be shared with somebody at the other end of the world . . . that technology challenges me to think about what is not easy ... I like to know the rules of the game, and then experiment."

The technology program network generates exchange among teachers, schools and regions and has contributed to the creation of a new professional sense of belonging, which is strengthened by their participation in the Advisors and Tutors Conference as well as the Children's Conference which are held alternatively every other year with the specific purpose of fostering a new social and professional network. Furthermore, the yearly training sessions are accredited by the Costa Rican Civil Service for salary increases and promotion in their professional career, thus con-
tributing to a new category of teachers within the educational system.

In Chile, similar benefits derived from collaborations with university faculty, training experiences, and simply having access to the technology.

In Chile there was evidence that technology also was functioning as a catalyst for collaboration within schools. The Chilean country team reported that teachers in that country typically spend most of their time working alone in their classroom and have few opportunities for exchanges with other professionals. Several of the case study schools reported improved relations among teachers, more mutual assistance and greater respect. This within-school collaboration appeared to be a by-product of the increased contact with external resources (e.g., university faculty) and the fact that those teachers receiving outside training were under an explicit or implicit obligation to impart their new learning to their colleagues.

This effect seemed particularly strong at one of the case study schools. The principal reported,

“We are abreast of changes, people are implementing these changes here and now. Several colleagues are attending courses on the holistic method and then they tell us what they have learned and in this manner we continue learning ourselves...”

A teacher in the same school commented,

“All of this is exciting because... this year there are several colleagues who are taking different courses, as something new comes along there are people that are applying to attend. We did not participate before because we lacked contact with people; we are in close contact with the universities [now], thus we are up to date on what is going on... in all schools, exchanges among teachers in different grades have been taking place.”

The coordinator in the same school reported,

“We have had to work with colleagues with whom I had never spoken, and I realized that they are great and that I had not known them... all of a sudden they had to sit down face to face with a team, and one is experienced and the other is not, and they have to help each other and they need to talk.”

Self-esteem and Changes in Gender Roles. In Chile, participating in a technology project and in university training has made teachers in the sampled schools feel that they have moved to the forefront of their profession. Relationships have been formed or strengthened both between teachers locally and with other institutions, such as universities that are providing training and technical assistance.

A Chilean principal reports:

“Until a couple of years ago, if we met with professionals who knew about technology, we didn’t know what they were talking about. It is so different when you can talk to other professional groups... and ask, ‘Why do you say that?’ ‘How is that going to be?’ and this knowledge gives you status as a professional. Consequently, there has been an impact on the self-esteem of teachers and on their interest to renew their methodology.”

Such effects on teachers’ self-esteem may be particularly salient in countries where teachers are predominantly women and technology is regarded as a male domain. Of note, all of the Costa Rican tutors and Chilean technology coordinators in the case study schools were women.

In Costa Rica tutors and advisors showed that the introduction of technology within a perspective centered on the individual, definitely changes self perception and promotes change in their personal and professional domains. Tutors report feeling comfortable
with and interested in technology, value themselves as "capable of learning," therefore changing their relationships with their students, as they can see themselves as learners and not only as "the ones who teach." This change is particularly meaningful within the Costa Rican educational system where women have traditionally outnumbered men as teachers, but not as administrators or innovative leaders. This change has given Costa Rican teachers a real possibility to modify their traditional role. This has been expressed by one advisor who says:

"Technology is no longer something cold and rigid, unreachable, its not just for mathematicians or wise people or scientists; it is one more tool to serve mankind and people have to learn how to use it for creating a better world with more justice for all."

Learning Experiences. In both countries, teachers report that contact with the technology program has given them valuable professional learning experiences.

In Costa Rica, the training and technical assistance the tutors receive emphasizes the kinds of collaborative, creative learning and problem-solving experiences the program seeks to encourage in the teaching and learning process, as well as technical proficiency in Logo programming. In addition, the program has underscored the importance of continuous learning for teachers. Further, in Costa Rica, the laboratory tutors reported gaining a sense of accomplishment and confidence from their technology learning that spilled over into other aspects of their lives. One tutor stated that this increased confidence in her ability to learn and to surmount obstacles had changed the way she relates to children:

"...it [learning to use technology] changes people totally. It gives people confidence. It makes us more outgoing and gives us self-confidence. . . . I may have been withdrawn, always too shy . . . this fear to talk, the fear to make mistakes. And with the technology this is no longer the case. If I do something wrong, the worst case would be that I would need to reinstall it, call the technician."

This self-confidence also enables teachers to accept the idea that they do not need to know everything about how to use the technology; teachers can learn in front of their peers and receive praise for helping others.

9. Impact on School Relations with the Community

In both Chile and Costa Rica, principals reported that participating schools have acquired prestige and stronger linkages with their surrounding communities as a result of the technology initiatives and that parents view the technology programs as special opportunities that they wish to exploit. Computers and Internet resources are potent symbols of power, achievement, and opportunity in high-poverty communities. As reported by a Chilean principal:

"I have seen the motivation in the parents, their gratitude. . . . Just the other day a parent told me, 'You know, I never thought that my son would ever touch a computer. I am poor; I am uneducated, and my son is bringing things home that he made in the computer! And he tells me that he saw this and that, and he gets in, he really did it; he had his hands on the computer."

In another example, teachers at a Chilean school reported that parents have greater pride in the school and spend more time at the school observing computer-based activities as they wait for their children to finish lessons. Principals in the Costa Rican case study schools gave similar reports. In both countries parents have some latitude in choosing schools for their children and principals cited a positive effect of the computer-supported learning programs on school enrollment. Reportedly, some parents even try to change
their addresses so that their children can attend a school with a technology program.

Other evidence of parents’ involvement with, and sense of pride in these schools is their contributions and fundraising. As explained earlier, in both Costa Rica and Chile, the community works with the participating school to provide a suitable workspace in terms of elements such as lighting, security and temperature regulation as a prerequisite for the installation of the computers.

Both programs also have increased community linkages by providing parents and other community members with access to the computer facilities. In Chile, the Enlaces technology resources are used for adult education and other community programs. In one Chilean school, for example, the computer lab is open for community use after school hours by the neighbors’ association, homeowners, and community members generally. Says one Chilean principal: “there are always people from the community here in school, and ...the school is totally at their service.” In that same school the coordinator holds classes for young people and adults from the city during the evening, using the schools computer room and equipment.

The Costa Rican program brings parents into the lab for award ceremonies and project presentations. Through a separate Omar Dengo Foundation project, technology programs for adults are offered in the computer labs during off-hours such as weekends and evenings. One of the schools in the study has had an extracurricular computer club for several years which services “former students who want to do high school projects or assignments.” The advisor highlights the fact that tutors provide these students with all the necessary supplies to work because “there is openness, a broader sense of service for former technology program students.”

These observations suggest that the successful implementation of a technology program at the school level may be both facilitated by and a contributor to community cohesiveness.

V. CONCLUSION

This study provides a qualitative analysis of two different school computer programs in Latin America. It is not so much a comparative study as a study in contrast. While Chile and Costa Rica faced many of the same problems in the design and execution of their computer projects, they went about solving these problems in quite different ways. While the conclusions drawn from this study are based on a small sample of schools in both countries, and do not necessarily represent the programs as a whole, they provide useful signposts as to where these programs have come and where they might be going in the future.

Program Design. Costa Rica pioneered the introduction of computers in primary schools in Latin America. Its program, which was launched in 1987, was designed as a total system underpinned by constructivist pedagogy and the Logo programming language. Its goal has been to contribute to the transformation of Costa Rican education though changes in teaching and learning that are brought about by the use of computers, the training of teachers, and the excitement generated by children’s self directed learning, knowledge creation and problem solving. The program was designed to enable at least one-third of the country’s primary school students to have reasonable access—80 minutes a week—to computers in a laboratory setting, working in groups of two per computer with the help of laboratory tutors. The program further seeks to build cumulative learning by offering the program to children in all grades, from pre-school to the end of primary. The laboratory tutors in each school provide students with guidance, support and instruction; classroom teachers are generally not involved in what goes on in laboratories, although we observed some examples of students working on
projects which stemming from classroom instruction.

Chile’s Enlaces program is a relatively new program which began operations as a small pilot program in 1993 and has grown rapidly into a broad-based national program. In contrast to Costa Rica’s program, Enlaces is not underpinned by any particular educational philosophy or pedagogical approach. It was designed as a computer network project in which participating primary schools were given the opportunity as one of the first in Latin America to use computers for on-line communication. Chile also required its schools, as a prerequisite to participating in the program, to design an educational project for using computers and to involve a minimum of 20 teachers in using the technology. Thus, there is great diversity in the way Chilean schools use computers in education and a higher proportion of teachers making direct use of the technology. Moreover, student-direction, project-based learning, and small-group and collaborative approaches are encouraged through MECE, the national education reform to which Enlaces is linked.

As the observations in this study illustrate, Chilean schools generally have fewer computers and higher student/computer ratios than Costa Rican schools. The result is less access per student, unless schools limit the use of computers, which they often do. Although high student to computer ratios were less marked in the schools selected for this study, Costa Rica also has had to limit access to computers to certain students in some very large schools in order to ensure a minimum of two hours of laboratory time per week for each participating student.

Training. Costa Rica and Chile have adopted different approaches to training. Costa Rica’s training is continuous, requiring advisors and laboratory tutors to attend classes every year. Costa Rica also offers initial training for principals, regular classroom teachers and other educational officials. Its training programs have covered many topics, both theory and practice, but have always had a constructivist underpinning. Most recently, tutor training has focused on the theoretical aspects of constructivism. The Costa Rican program supports the continuous training of their staff and draws upon their collective resources and experiences in conducting training activities, which remain under the direct purview of the Omar Dengo Foundation, supported by the Ministry of Education. In contrast, Enlaces’ training program lasts only two years, but requires the participation of a broader cross-section of school-based staff. The Chilean program trains not only school-based coordinators, but also school principals and a minimum of 20 teachers per school. Schools which enter the program are required to involve clusters of teachers in basic short-term training courses which are geared to providing computer literacy and instruction on the use of Enlaces’ La Plaza interface. In the pilot phase, the Enlaces management team provided training directly to schools. As the program has expanded, universities throughout Chile have been contracted to provide training and other support services to schools. Enlaces also continues to offer teachers more specialized training in the use of available software and in other applications. However, such training is not obligatory and not all teachers take advantage of its presence.

Impacts. Despite their many differences, the two countries’ programs appear to have similar kinds of impacts. In both cases, the program is reported to have led to greater prestige for the school within its community, with positive impacts on enrollment and community interactions. Students feel increased pride and more of them aspire to finish school and go on to technical careers. Teachers involved in using technology feel a growth in prestige; they feel revitalized professionally and start reaching out for more training and involvement in collaborative projects.

The second area of impact appears to be on the social organization within the classroom. Although not universal, the tendency is for students and teachers to move toward more egalitarian relationships, with
students making more decisions about their own work, speaking their minds more freely, and receiving consultation rather than lectures from their teachers. In several sample schools, this new mode of organization seems to have spread from the computer lab to the classroom. Under these more self-directed circumstances, teachers reportedly see capabilities in their students that were not observed prior to the introduction of technology in the schools.

The present study did not address the impact of the technology on student learning, but provides descriptive information about the impact of computers on roles and behaviors. A much larger, prospective study would be needed to provide systematic evidence concerning learning outcomes. Nevertheless, the kinds of changes in behaviors and processes documented in this study—the increased motivation on the part of students and their teachers, the greater focus on working with small groups or individual students and diagnosing their level or understanding rather than rote memory—are good predictors of student learning.

**Looking Toward the Future.** The two projects which were the focus of this study are undergoing important changes which merit the continued attention of policy makers and specialists interested in the issues of computers in education. *Enlaces* is fast becoming a large national program which will make the Internet increasingly available to teachers and students in Chilean schools. This development promises to bring about new and exciting opportunities for using computers for teaching and learning in the next century. Meanwhile, Costa Rica is launching a new phase of its computer program in primary schools which has many exciting features including a new computer platform with up-to-date telecommunications and multimedia capabilities. It is also expanding the program to multi-grade schools, investing in the pre-service training of teachers and helping teachers acquire their own personal computers at a discount. Training and follow up will take place increasingly through distributed learning processes using Internet and Intranet sites. In turn the Costa Rican Ministry of Education has expanded its high school program to cover 100 percent of high schools. All of these efforts are ushering in new teaching and learning experiences in Costa Rica’s schools preparing youth for the 21st century.
REFERENCES


