CREATION OF A COSTA RICAN LABOR FORCE FOR THE KNOWLEDGE ECONOMY: *PRIMARY SCHOOLS*

John Hewitt

jhewitt@interamerica.net

JUNIO, 2004

San José, Costa Rica

Executive summary

This document presents the results of an investigation by the Costa Rican High Technology Advisory Commission (CAATEC) into the Costa Rican primary educational system, intended to identify the problems which the system faces in trying to create citizens that are prepared to participate effectively in developing information-oriented economies and societies, and to make recommendations about how this goal can be achieved.

The distribution of schools and students in terms of local income levels, rurality, school sizes, and other important attributes is described at the beginning of the document, serving to highlight the outstanding challenge the national educational system faces in trying to supply a very large number of small rural schools with the same level of resources that can be made available to larger urban schools.

The effects on students' academic performance of variations in factors such as poverty, rurality, teacher qualifications, numbers of teachers, and student-teacher ratios were investigated, and the negative effects of several of these factors documented. During this stage of the analysis, a special sensitivity of students in the first years of primary education to variation in these factors was found, as well as strong evidence of a need to improve teaching in mathematics, and an interesting tendency to pass students in unusually high numbers at the end of primary education.

The availability of computers, Internet access, and training in their use was investigated, and the implementation of this technology and related training was found to be taking place first in larger (and mostly urban) schools, only slowly penetrating into smaller rural settings, leaving a substantial portion of Costa Rican primary school students in rural areas without access to these tools for the foreseeable future.

Data from CAATEC's own survey of students and teachers in 51 Costa Rican primary schools confirmed this picture. It also showed that specialization in teacher training is limited primarily to computing, and that while teachers place high priority on the need to improve mathematics teaching, they see little need to improve teaching quality in other areas of special importance to information societies, such as science.

The school survey showed a remarkably high level of enthusiasm on the part of students for the use of computers, and strongly favorable attitude towards mathematics, balanced by a lower level of enthusiasm for science, and significantly lower appreciation of subjects such as Spanish and social studies. When students evaluated the probable future usefulness of the subjects in which they were currently receiving education, they gave high scores to computing, mathematics, and English, while once again regarding science as of limited importance in their future lives.

A second survey, of 114 Costa Rican scientists, showed that current scientists tend to come in disproportionate amounts from larger urban schools in wealthier areas of the country, and that they tended to have been interested in science, and to a lesser degree mathematics, from elementary school on. Their evaluation of the subjects that they were trained in in primary schools which were useful in their adult lives differs sharply from current primary school students in having science training at the head of the list, but matches other student perceptions quite well by placing mathematics and English as extremely important.

Recommendations made on the basis of the foregoing include providing increased funding for the extension of computer and Internet access and training to those schools which have not yet received it, and the dedication of resources to improve the state of teaching in mathematics and science.

Table of Contents

Tables

Figures

Creation of a Costa Rican Labor Force
for Knowledge Economies (1):
Primary Schools

I. Background

The economies of more developed nations have typically passed from an initial dependence on agriculture with a primarily rural workforce to industrial manufacture of goods in or near cities, and have further evolved in the last few decades towards an increasing dependence on providing services in place of manufactured goods. These stages are often used to categorize national economies, with the implication that they represent stages of progress from “underdeveloped” agricultural countries towards “modern” industrialization and service provision.

At the same time that service economies began to flourish, Information and Communications Technologies (ICTs) also began to undergo explosive transformation and growth, providing unparalleled access to the information necessary to make the multitude of decisions involved in economies of any scale – an access that is especially important as forces of globalization create enormously complex international marketplaces. As access to information has become more widespread, these technologies have become not only a cause of intense competition between providers of goods and services to increasingly well-informed buyers, but also a critical factor in determining competitive success or failure in economies that are increasingly embedded in globalized telecommunications networks.

The effects of increased global competition have had an enormous impact on the Costa Rican economy’s traditional basis in agriculture and agricultural exportation, where during the last decades growing cost-based commodity market competition with other less-developed countries, along with highly volatile international commodity prices, have threatened the country’s relatively high standard of living and extensive government-provided social services.

Costa Rica’s response to this situation has not involved a movement towards industrialization, due both to a lack of appropriate resources and a strong environmentalist ethic. Instead, it has emphasized the production and exportation of higher-margin non-commodity agricultural products (e.g., gourmet coffee, decorative plants), tourism, and the provision of services – often to multinational businesses which are attracted to the country by its political stability, traditionally high levels of education and bilingualism, and relatively low wages. Another possibility that of generating the intellectual property which increasingly forms the basis of wealth in “information-based economies”, is only now beginning to be seriously emphasized, as can be seen, for example, in the government’s strong support for the national software industry

The effective use of information, and the information systems that make it available, are critical to activities in all of these newer areas of emphasis, including the creation of new information-based products and services. The Costa Rican formal educational system, with its public and private institutions, is responsible for the creation of much of these human resources, but warning signs are appearing that the system is no longer capable of producing enough of the kinds of people that are necessary to maintain the transformation of the national economy from traditional, non-ICT-enabled agriculture towards more profitable and sustainable activities.

As is the case with public education systems around the world, the Costa Rican public system – the responsibility of the Ministry of Public Education (MEP) – constantly faces a number of critical issues related to the accessibility and quality of national education. The most highly-publicized of these issues in recent years have included budgetary problems (affecting teachers' pay, student bus transportation, student meals and even the length of the school year), an alarming drop-out rate for post-primary students, and serious debate about the quality of primary-school teaching in critical areas such as mathematics[1]. While the MEP is taking steps to remedy these problems to the degree that it is able, there can be no doubt that the public educational system is experiencing severe stresses.

Information pertaining to the quality of the technical and scientific education of Costa Ricans also shows some grounds for concern. Studies by the organization in charge of the international promotion of Costa Rican industry and the attraction of Foreign Direct Investment (FDI)[2], as well as by the Chamber of Costa Rican Software Producers[3] and the Costa Rican High Technology Advisory Commission (CAATEC)[4,5], combine to show that skilled workers in the areas of science and technology are in scarce supply, and that skills in the existing workforce in the areas of problem-solving, scientific and mathematical abilities, management and foreign language proficiency are often regarded as inadequate by employers.

This situation is especially significant in light of Costa Rica's traditionally high levels of education and literacy – the country may be falling behind in areas in which it was once a world-recognized leader, at a time when the quality of education and human resources is becoming absolutely vital to maintaining competitivity in the global marketplace.
The rest of this document presents the results of the latest in a series of studies carried out by CAATEC to provide data, analyses, and recommendations that will be of use in the process of maintaining high-quality Costa Rican education. Its general approach reflects CAATEC'S strong interest in the creation of a public that can take the best advantage of evolving technologies and scientific and technical training to improve their lives, and its specific focus on primary education reflects the fact that this is the first step in a study of Costa Rican education at successively higher stages. As such, one of the most important outcomes of our study will be to provide a baseline against which results of future studies at higher levels of education are compared; however, the results are also useful in themselves, since they point out some areas in which major problems can clearly be discerned.

This study could not have been carried out without the generous support of the Interamerican Development Bank (IADB) for the general analysis of primary education,

[1] "*Enseñanza de la Matemática es floja*"; <www.nacion.com/ln_ee/2003/septiembre/29/pais3.html>
[2] *CINDE/PROCOMER (2001). Condiciones del Mercado Laboral para los Sectores de Alta Tecnología en Costa Rica. Sectores: Electrónico, Eléctrico y Dispositivos Médicos. San José, Costa Rica. mimeo*
[3] *CAPROSOFT (2001). Estudio de Oferta y Demanda del Recurso Humano. San José, Costa Rica. BID-CAPROSOFT-PROCOMER-FUNCENAT*
[4] *Céspedes, Oswald and Carlos González (2002), Recurso Humano para Empresas Multinacionales en Alta Tecnología en Costa Rica: Análisis de la Oferta y Demanda. CAATEC, San José: Costa Rica.*
[5] *Loría, Miguel and Faustino Montes de Oca (2002), Servicios de Telecomunicaciones en Costa Rica: La Experiencia de Empresas Multinacionales en Alta Tecnología. CAATEC, San José: Costa Rica.*

and the equally generous support of the Costa Rica – United States of America Foundation for Cooperation (CR-USA), which supported an extremely informative questionnaire-based field survey of students and teachers in 51 primary schools. We would also like to acknowledge the support of staff members of the Ministerio de Educación Pública (MEP) and the Fundación Omar Dengo (FOD), without whose professional and courteous assistance this report would not have been possible.

II. Focus and Methodology

It is necessary to define as clearly as possible for the reader the focus of the current study, and the methods that were used to gather and analyze relevant information. In the present case, the following factors and decisions influenced our approach:

- By far the best existing central source of information about education in Costa Rica is the MEP, and the information it has is naturally oriented towards the administration of *formal educational institutions*. An additional invaluable source of information is the Fundación Omar Dengo, which is responsible for the great majority of computer training in Costa Rican public primary schools – once again, within the formal educational system. We have no sources of information of comparable quality that would allow us to study the impact of *informal* learning from family and friends (although our independent questionnaire results have some information on this vital subject), or through on-the-job training and self-study.

- Within the area of formal primary education, we will be making special mention of the areas of *education in sciences, mathematics, and technology*. These areas are commonly regarded as being of special importance in providing basic intellectual tools for the creation, analysis and use of information and information systems, whose special importance in new economies was mentioned previously.

  We acknowledge that education and experience in many other areas are undoubtedly vital to the actual operation of information economies, such as business and entrepreneurship, government, and even social skills[6]. However, of the four major subject areas for which we have information (Spanish, social studies, science, and mathematics) science and mathematics seem to be the most directly related to the learning of critical thought and problem solving abilities – themes which are also stressed by the Fundación Omar Dengo as outcomes of the training in use and programming of computers which is a major part of the Fundación's curriculum. Given the current global emphasis on the creation of valuable intellectual property through scientific research in such areas as medicine and biotechnology, electronics and engineering, and computer science, we feel that paying particular attention to these areas is justifiable.

- The initial study will have its main focus in the area of *primary education*. Since education is a trajectory composed of successive stages, each building on what has gone before, understanding complete educational trajectories of students will always require a firm understanding of their beginnings. We believe that a first-stage study should start at the beginning of a process.

  An equally obvious focus would begin with a study of students' last years within the educational system, when their curricular choices and performance more clearly indicate their final destinations in the workplace. However, the proposed study is aimed at defining steps that can be taken to systematically and permanently remedy a potentially

---

[6] *"What's it Worth?" The Economist(1/15/04) <www.economist.com/displaystory.cfm?story_id=2352932>*

worrisome situation, and focusing on problems that are only detected when students are at the point of entering the work force leaves little or no opportunity for implementing solutions whose effects will be felt in time to make a consistent difference.

The overall frame of view throughout our analysis of education at all levels is based on the concept of a "critical path", in which formal education is regarded as an input-output process in which cohorts of students enter school at the primary level, and then begin to exit the system at various points in time, with certain kinds of knowledge and skills. While within the system, students are exposed to certain subjects in which they perform with various levels of success; they also follow trajectories within they system – at first, moving from one fixed grade level curriculum to another, and later being able to choose among alternative offerings based on personal abilities and preferences.

The curriculum for primary schools in Costa Rica is highly standardized in primary school, and we will not see students choosing different educational options in these first years in school. In addition, enrollment in primary education is very high in Costa Rica (although there are certain barriers to entry in some areas of the country, such as financial resources for basic supplies, meals, and transportation), and the rate of premature exiting of the system is relatively low (estimated at slightly more than 4% overall[7] for the year 2001, which is the year to which almost all of our information pertains).

In later stages of our studies, when we deal with secondary and higher-level education, the study of factors that contribute to ominously higher dropout rates will assume a far more important role in our discussions, and we will begin to see more variability in the trajectories that students that remain in school follow. When this happens, the image of a "critical path" among many possible paths that leads to the outcomes that we desire will assume a far clearer significance than it has in this initial study, in which there are in fact very few possible paths for students to follow except leaving the system prematurely or taking more than the normal time to complete the primary program.

Nonetheless, the results of this first-stage study provide information that will be invaluable in understanding the factors that influence the paths of students through higher levels of the educational system, which will in turn help us to understand how the system can be managed and adapted to help achieve the long-term objective of creating more and better-prepared human resources for information-based societies.

[7] *Politicas y Acciones Estratégicas. Plan Educativo 2002-2006; pg. 11 (2002). Ministerio de Educación Pública, San José, Costa Rica*

III. Data

The basic data for a study of the sort described above includes information about students, teachers, schools, and relevant information about the communities and wider areas in which education takes place. The following is a short discussion of our sources of information, and the quality and consistency of this information.

A. Sources

1. External factors

The most commonly mentioned influence on the quality of education is the amount of *financial resources* available to parents, the community, the educational system, and the nation. The most consistently useful indicator of the local availability of financial resources for our purposes came from the results of the year 2000 national census data provided by the Instituto Nacional de Estadisticas y Censos (www.inec.go.cr), in which proportions of the population with "low", "medium", and "high" incomes were estimated for each of the 459 districts in the country (which are subdivisions of the country's 81 cantons, which are in turn subdivisions of 7 provinces). The proportion of each district's population with "low" incomes was used as a general indicator of economic conditions within a district.

Another factor of great interest is that of *relative urbanization or rurality* of the area in which a school is located. The degree of rurality of an area is related in many ways to economic factors, since economic development often takes place in high population concentrations before its impact is felt in more dispersed rural populations; in the case of education, the simple distance between schools and students, and the generally smaller number of students in rural schools compared to urban schools, may have very strong effects on the cost and quality of education.

Data from the year 2000 census concerning the proportion of the population that lived in "urban" and "rural" areas in each district was available, and the proportion of "rural" population was used as one of our general indicators of rurality/urbanization at a district level, along with information provided by the MEP classifying primary schools as "rural" or "urban", and information from our own in-depth survey of 51 schools.

Finally, the Year 2000 census supplied us with information about the district-level penetration of certain vital kinds of *infrastructure*, such as electricity, telephones, and even computers; all of these were used at some point in our analysis to shed light on our findings.

Other relevant indices at the level of cantons were considered, such as information helpfully provided to us by the directors of the State of the Nation Program about the number of community organizations in each canton in the year 2000[8] – a possible indicator of community solidarity and social integration – and a ranking of the quality of education in the various cantons of the country in the year 2003 produced by a study financed by the World Bank, which took into account numbers of teachers, infrastructure,

[8] See *Auditoria Ciudadana Sobre la Calidad de la Democracia, vol 2, pg. 316. Proyecto Estado de la Nación, San José, Costa Rica (2001).*

computer penetration and other factors[9]. While informative, we preferred to work with data with a more local focus (at the level of districts or schools), and in any case attempts to relate these indices to other factors were generally unproductive.

2. Students

Our basic information about students comes from two sources – the MEP, and our own survey of 51 schools. The most important information provided by the MEP pertains to the 2001 school year (the latest available complete data when it was supplied in the first part of 2003), except where noted otherwise, and includes the following:

- Number of students in each grade of each primary school – used not only to categorize schools by enrollment size, but to assist in the calculation of student/teacher ratios
- Number of males and females in each grade in each primary school
- The number of students passing each of four major subjects (mathematics, science, social studies, and Spanish) in each grade in each primary school – used to calculate the percentage of students passing different subjects in different grades, and more general percentages for entire schools and districts
- The number of students taking and passing the special 6th-year exams in each of the four main subjects in various primary schools (this for the year 2002) – used to calculate a possible independent indicator of the impact of 6th-year education.

In addition, our 2003 survey of 387 2nd- and 6th-graders in 51 schools produced information in the following areas:

- Sex, age, and grade of students interviewed
- Use of computers and Internet in the school and the home
- Parental assistance with various subjects
- Comments from students about how much they like various subjects, and how useful they think what they learn in different courses will be in the future

3. Teachers

Initial information supplied by the MEP for the year 2001 related to teachers included the following:

- Number of professors in each school (used to estimate student/teacher ratios; in some cases data from the year 2002 which made clearer the distribution of teaching and non-teaching staff was used to refine and categorize the 2001 data)
- Civil service grade of professors (an indirect indicator of teacher experience)

[9] *Banco Mundial hizo "ranking" de 81 cantones. La Nacion 11/09/03. <www.nacion.com/ln_ee/2003/ noviembre/09/pais2.html>*

Our 2003 survey of 99 teachers in 51 primary schools produced the following information:

- Subjects taught
- Academic qualifications and civil service ranks
- Opinions about the current state and probable future state of primary education – in the school in which the teacher works, and in the country as a whole
- Opinions about the areas which most urgently need attention to improve primary education – in the school in which the teacher works, and in the country as a whole

4. ICT Infrastructure

We have information about ICT infrastructure of primary schools from two sources – the FOD data for 2003 gives us a good idea of which *public* schools have computer laboratories (and the year in which these laboratories were created) and some idea of which schools have or once had Internet connections; from our own 2003 survey we know which of the 51 schools studied have computers, computer laboratories, and Internet connections.

5. Scientists

CAATEC created an online questionnaire containing several of the questions that were asked to students in our survey, and requested via e-mail that several hundred Costa Rican scientists – members of the National Council for Scientific and Technological Investigation (CONICIT) and younger scientists who had received scholarships to complete post-graduate degrees in other countries – to assist us by filling out the questionnaire. As of the writing of this document, we had received 114 replies, and the information that these scientists provided about where they went to school, what their opinions of various primary school courses was, and how useful what they learned in those courses was in their professional lives, provides us with an interesting reference point when interpreting the results of other parts of our analysis.

B. Quality, consistency, and distribution of the data

Our 2003 survey of students and teachers in 51 schools produced the information most clearly focused on areas that are of particular interest to the present study, but we were quite pleased with the quality of the information that we obtained from the year 2000 census, the MEP, and the FOD, given the inevitable gaps between our own interests and those of the persons and organizations that originally collected the data. Nonetheless, we need to mention several aspects of the data that must be remembered when discussing our later analysis and conclusions.

It is extremely useful to be able relate data about students, teachers, and schools to other data about local income levels, rurality, and infrastructure penetration. However, such data is only available at the level of entire districts, whereas we would like to have information at a much finer scale – at the level of neighborhoods, for instance. In most cases, such data is not available and we have to crudely estimate local values from district data; in the case of rurality, we have a simple "urban/rural" value for each school from MEP data in addition to values from district-level census data.

It was instructive to compare values from these different sources for the same schools; when we did, we saw that districts which have mostly urban inhabitants (and all of whose schools would be estimated to be "urban" using district data) can sometimes have pockets of rural inhabitants and schools which are only detected by the MEP school-level data. There was no similar problem in the opposite direction – there were no "urban" schools in districts that were rated as "rural" using the district-level census data – from which we conclude that there are probably more "rural" areas in the country than our indicators are showing.

Problems of this sort are the reason why we prefer not to use even more imprecise canton-level indices and estimates in our analysis when we can avoid it; the district-level estimates of community parameters give us enough results that are consistent with other lines of evidence in our data to make us comfortable with using them with due caution.

Secondly, we have always been careful not to forget that our data was sometimes gathered in different years. The majority of MEP information about students and teachers pertains to the 2001 school year, which was the latest year for which relatively complete information was available when the study first began in the second quarter of 2003; however, we made use of MEP information from 2002 to help us calculate year 2001 student/teacher ratios, and briefly consider 2002 special MEP 6^{th}-grade exam results for comparative purposes.

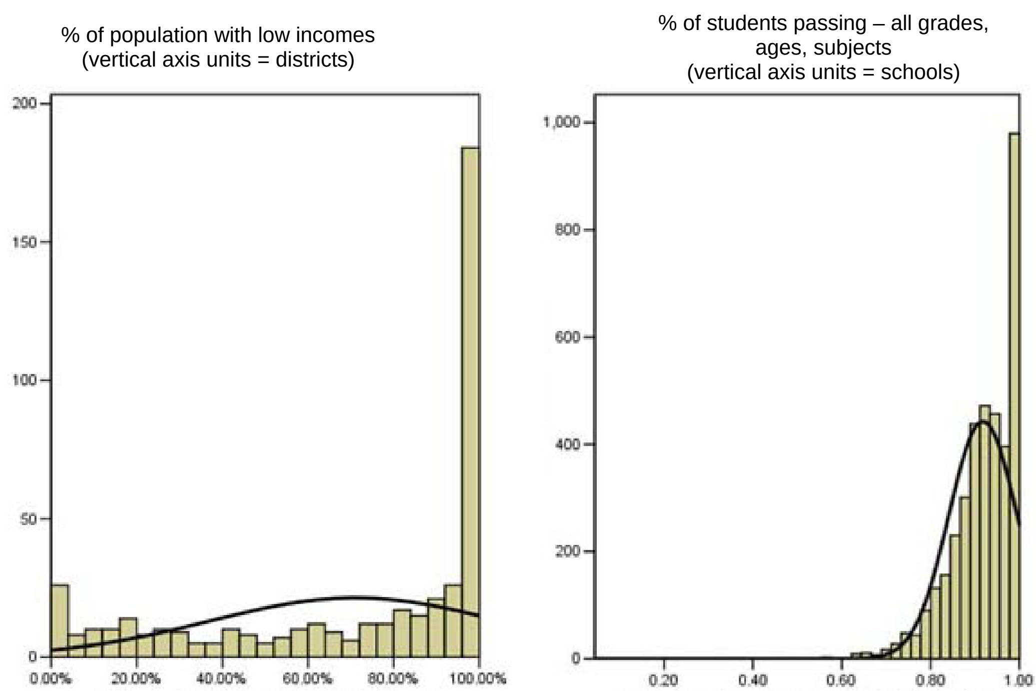
Although the information we received from the FOD covered up to the year 2003, it fortunately included the dates in which member schools entered the program, which allowed us to both specify schools that had laboratories in the same year our main MEP data covers (2001), and to see how coverage has evolved in the following years. Most of our background information about economic status and urbanization of district populations comes from the year 2000, but we do not expect the relative statuses of districts to have changed notably between the years 2000 and 2001, and do not expect gross inaccuracies from using 2000 census data to stratify 2001 student and teacher data.

Thirdly, we received information from various sources and databases within the MEP and the FOD, and as is typically the case in *post hoc* analysis of data from different sources, inconsistencies were often found when the data were integrated and filtered. These variations affected such variables as numbers of students and teachers, presence or absence of computer laboratories, computer classes and Internet connections, and even the number of primary schools themselves.

All possible efforts were made to reconcile data from different sources, and to eliminate schools for which figures from different sources varied widely; the basically sound quality of the data allowed us to resolve many of our problems. Nonetheless, there were many cases in which values from different sources for vital factors such as numbers of students and teachers in particular schools were not identical. We were able to accommodate relatively small differences by grouping schools based on ranges of values – "1-25 students", "26-50 students", etc. – and in cases in which values diverged too much to be honestly accommodated by categories, the cases were eliminated from further analysis. Following this strategy did not prevent us from drawing interesting conclusions, and had the virtue of representing reality as well as the data would support.

Finally, we note that in many cases values for variables such as average district income levels, or percentage of students passing courses are highly asymmetrically distributed (see Figure 1 for example data distributions with expected normal distribution curves superimposed). In the case of the income level example, this is not a problem of inaccurate data, or insufficient sample size, but is simply a fact – a large number of districts have 100% of their inhabitants with low incomes. In the case of the distribution of percentages of students passing courses, the skewed distribution is influenced by at least two factors – that the range of possible values is truncated at 100% at one extreme, and that many of the schools reporting 100% pass rates are, in fact, small schools in which relatively few students need to pass to produce a 100% score. Eliminating such cases from the analysis is impossible, however, because small schools constitute more than half of our entire sample.

Figure 1:
Example data distributions



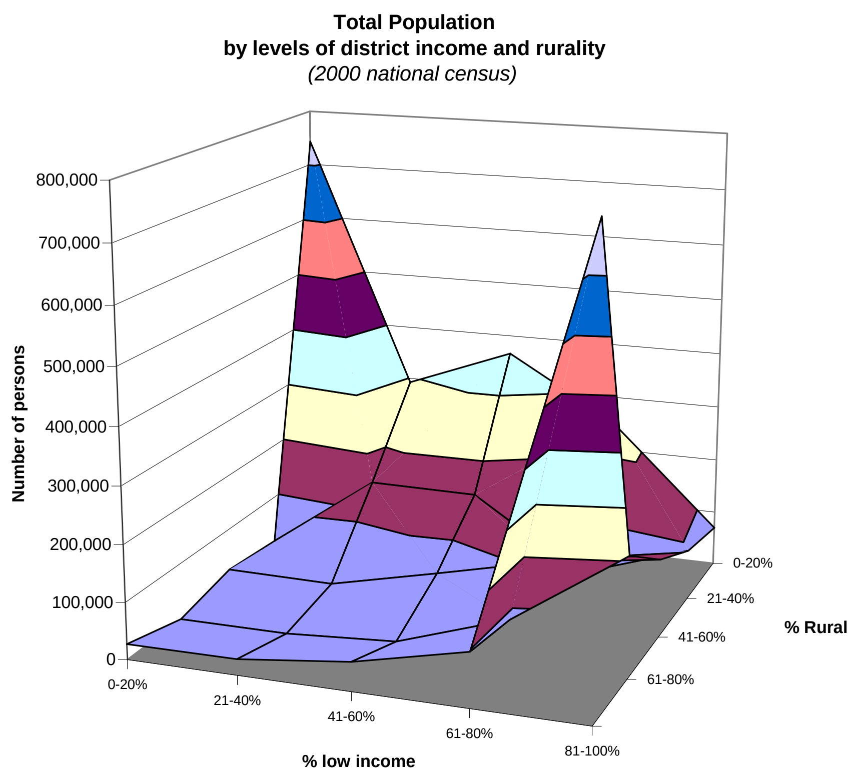
This common concentration of values within a small area or areas of much wider logically possible ranges of values complicates analysis of the data. Even using non-parametric statistical techniques that do not assume normal distributions of variable values, tests may provide “significant” results that simply reflect the fact that there is little variability in the data used in the analysis, rather than indicating important relationships between different factors. As a result, our statistical analysis of the data is often constrained to be more descriptive than inferential; but given the fact that we are dealing with data from the complete universe of Costa Rican primary schools, rather than a sample, even simple summarization of data in different categories can give us a great deal of useful information.

IV. Distribution of population and schools

As an initial step in our analysis, we performed cross-tabulations of several categorical variables based on information from the national census for the year 2000 and information about the number of students and schools in each district in the year 2001. We will primarily use graphical representations of the results of these cross-tabulations in the rest of this section; the data upon which the graphics are based are included in the Appendix at the end of the document. *Totals of schools and students in different tables in the Appendix and throughout this paper may vary due to the presence or absence of values for particular variables used in constructing the tables.*

As we indicated in our discussion of environmental variables in Section III, there are a number of reasons to be interested in the influence of income and rurality on education. Figure 2, below, is one way of visualizing the general relationship between these factors and the number of persons living in Costa Rica in the year 2000. In this and similar cases, the percentage of persons which was reported in the Census as either having "low incomes" or as living in "rural" areas was calculated for each district, an income or rurality category value in terms of successive 20% ranges (0-20% ... 81-100%) was assigned to the district based on those values, and the number of inhabitants of districts with the same category values were summed to produce the values depicted in Figure 2.

Figure 2:



As can be seen from the figures in Table A of the Appendix, more than 45% of the Costa Rican population lives in districts which are highly urban (with 20% or less of their populations living in rural areas). The peak in the data in the left background area of

Figure 2 shows that more than 43% of this highly urban population – slightly less than 20% of the country's total population – also lives in districts with 20% or less of their populations reported as having low incomes. This can be very roughly referred to as an "affluent urban" population component, if we are careful to remember that it includes neither all of the urban districts, nor all of the relatively affluent districts in the country.

The second major peak in Figure 2, in the right foreground, is due to a similar population concentration at the opposite extremes of the income and rurality scales. Slightly more than 26% of the national population lives in highly rural districts (80% or more of district populations reported as "rural"), and almost 80% of these highly rural district populations are also reported as having 80% or more of their inhabitants with low incomes – producing an almost exactly symmetrical "least affluent rural" concentration (that, once again, includes neither all highly rural districts, nor all districts with high percentages of low incomes) that contains 21% of the country's population.

We can immediately suspect that having a significant fraction of the national population in rural poor areas will represent a substantial challenge for the national educational system. We can take a slightly different look at this phenomenon by computing the average population densities for the different cells of the rurality-income matrix, on the assumption that areas with denser populations will be easier to provide with educational facilities (a relatively few, large schools) than will highly dispersed populations (requiring many widely-separated small schools). Using the information in Table A and Table B of the Appendix, we computed the figures in Table C of the Appendix; the data in Table C are presented in graphical form in Figure 3.

Figure 3:

Inhabitants / Km2
by levels of district income and rurality
(MEP 2001 and National Census 2000)

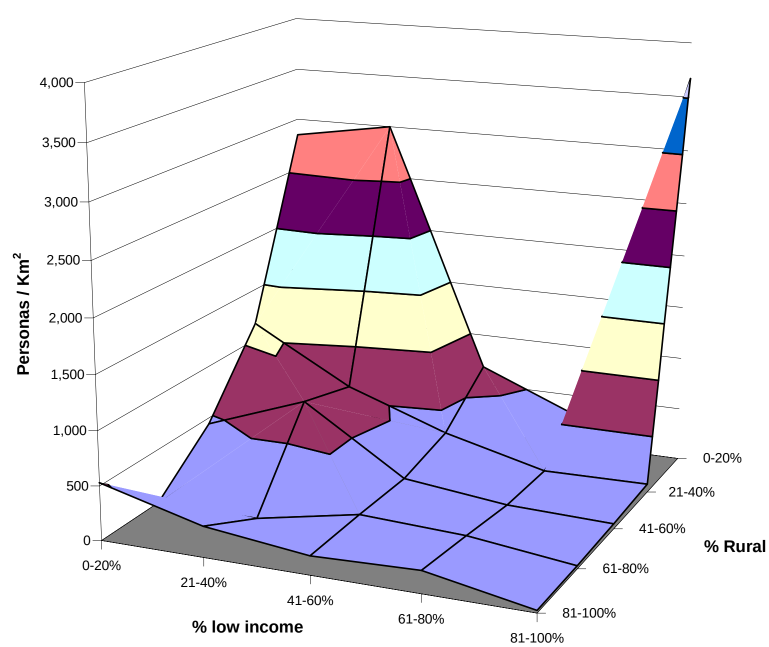


Figure three also has two notable peaks – one in the left background representing high population densities in more urban and relatively affluent districts, and another, in the right background, due to the presence of three small but densely populated urban districts with a high proportion of low incomes (Chacarita, San Felipe, and Concepción; the total population of these three districts is 69,520 persons – slightly less than 2% of the total population). In general, however, low-income districts do tend to have very low population densities, which supports our initial impression that less affluent rural areas will be especially difficult to provide with adequate educational infrastructure.

There are other kinds of infrastructure that are relevant to the current discussion, especially as they relate to the possibility of using computers and the Internet for education, and educating students about the use of computers and the Internet. If there is no electricity, then there can be neither computer nor Internet use; if there are few telephone lines, then there is little possibility of using even slow dial-up connections to connect schools to the Internet, and a very low probability of telecommunications infrastructure that will support faster dedicated Internet connections.

The year 2000 census figures for Costa Rica show almost universal (96.8%) household access to electricity, which implies that schools without electricity should be extremely scarce, although we will in fact encounter such schools in very poor and rural areas when we discuss our survey findings. Using the same rurality (rows) by low-income (columns) matrix format that we introduced previously, analysis of data pertaining to telephone access from 935,289 Costa Rican households reported in the census gives us the results in Table 1, below.

We assume that in even the remotest and poorest areas, schools have a higher probability of having a telephone line than the surrounding private residences in which their students live; however, to the degree that access to telecommunications lines is a problem, the figures in Table 1 give some support to the common-sense assumption that it will be far more of a problem for schools in poorer rural areas than in wealthier urban ones.

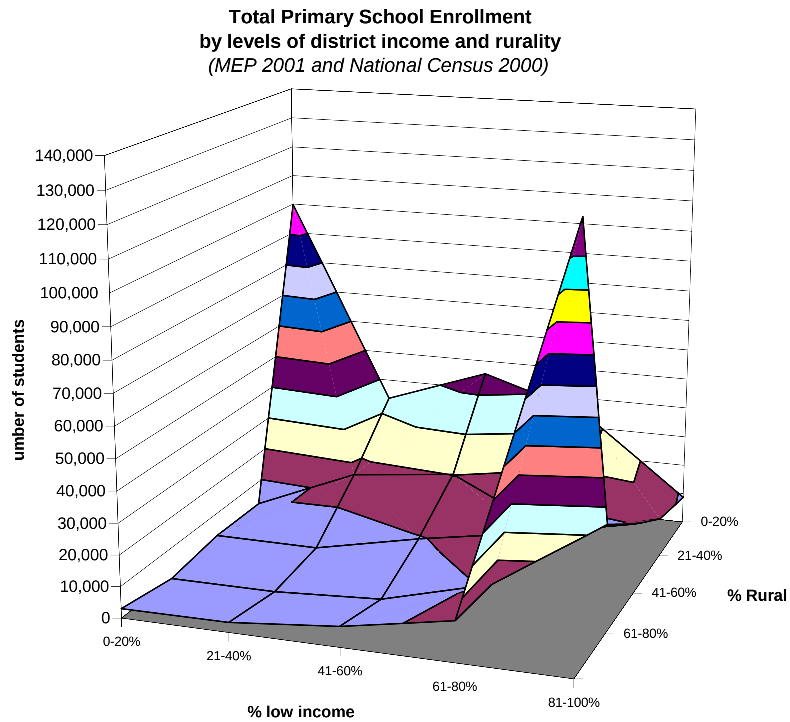
Table 1: Percentage of Costa Rican households with access to telephones by categories of district rurality and low income

	District income levels					
Rurality	**81-100%**	**61-80%**	**41-60%**	**21-40%**	**0-20%**	**TOTAL**
81-100%	20.35%	49.24%	58.64%	58.95%	63.29%	**27.57%**
61-80%	26.91%	43.86%	60.84%	--	--	**32.68%**
41-60%	33.02%	49.79%	58.63%	66.51%	71.38%	**47.43%**
21-40%	41.40%	38.16%	58.94%	69.29%	66.00%	**58.35%**
0-20%	57.66%	54.10%	66.94%	73.33%	82.42%	**72.87%**
TOTAL	**26.15%**	**50.30%**	**63.36%**	**70.99%**	**81.22%**	**54.32%**

Source: Year 2000 Household census (www.inec.go.cr)

Moving to a consideration of data that pertains specifically to primary school students and schools, we computed the number of students in each of the cells of our rurality-income matrix. The results of these calculations are included in the Appendix as Table D, and summarized in Figure 4.

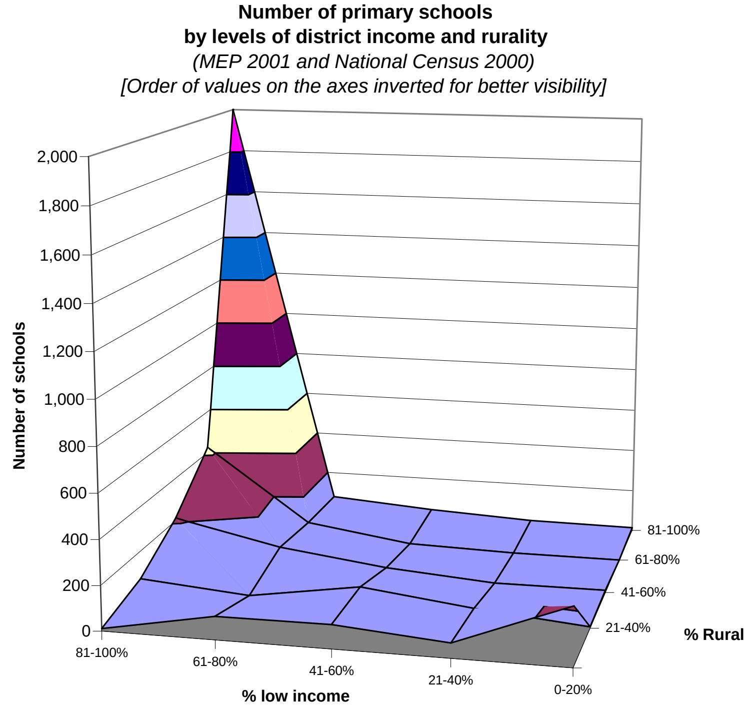
Figure 4:



The results naturally closely resemble the distribution of the general population, with a smaller number of total persons involved. In this case, we are speaking of 533,840 primary students, with 131,595 of them in areas with very high (80-100%) proportions of reported rural inhabitants and high proportions of low-income inhabitants (the right foreground peak), and 99,884 of them in areas with very high proportions of urban inhabitants and very low amounts of low-income inhabitants (the peak in the left background). The fact that almost forty percent of all students are in the most highly rural areas, and almost one-quarter of all students attend schools in the least affluent of these highly rural areas, signifies a clear challenge for the primary educational system.

This challenge is made even clearer when we consider the distribution of the number of schools using this same framework (see Table E in the Appendix, and Figure 5 on the next page). The preponderance of primary schools in the most rural areas with the greatest percentage of reported low incomes produces a peak so large in Figure 5 that it was necessary to reverse the order of values on the axes of the figure in order to see the representation of the rest of the data; there are 2019 schools in this category – more than half of the total of 3,892 schools for which we have relevant data.

Figure 5:



We repeated the same analysis of numbers of students and schools by rurality and income levels using the more exact MEP figures for "rural" and "urban" schools, which gave us the data in Tables F and G of the Appendix, represented in Figures 6 and 7. If anything, these emphasize the conclusions drawn from the discussion of the previous two figures – we now see almost 37% of all students in "rural" schools in areas of 81-100% low incomes (and 17% of all students in "urban" schools in areas with 0-20% of low incomes), while almost 70% of schools are "rural" in areas of 81-100% low incomes, and slightly more than 5% of schools are "urban" in areas with 0-20% of low incomes.

While we may see the same peaks of numbers of *students* at the opposite ends of the scales of urbanization and percentages of populations with low incomes in Figure 6 that we have seen in previous data, we do not see the usual peak for the number of urban *schools* at the wealthiest end of the spectrum in Figure 7. The numbers in Tables 2 and 3, on page 17, show that this is due to the fact that urban schools tend to have larger enrollments than rural ones.

Figure 6:

Number of Primary School Students by district income levels (national Census 2000) and geographical zones (MEP 2001)

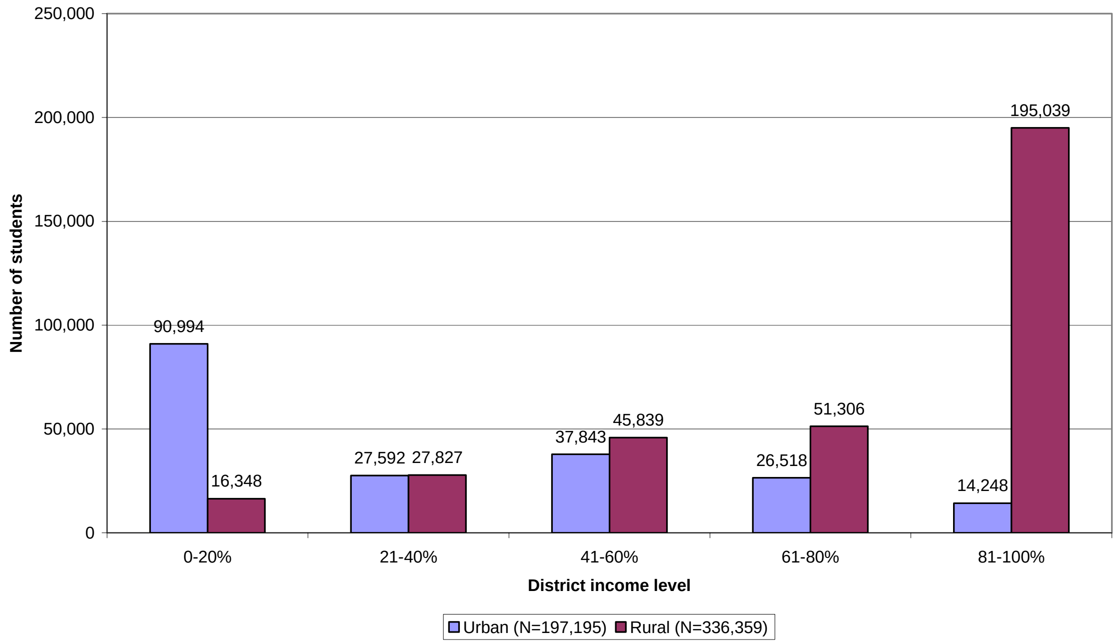


Figure 7:

Number of Primary Schools by levels of district income (national Census 2000) and geographical zones (MEP 2001)

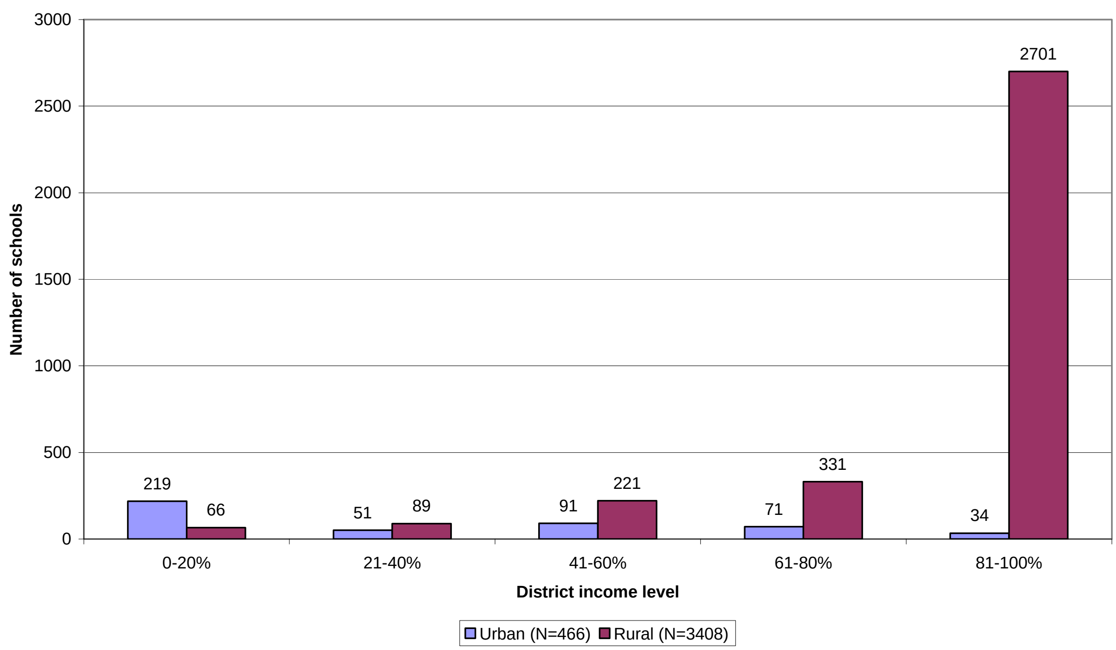


Table 2:
Number of students in schools of various sizes by categories of income and rurality

	% low income	Number of students / school 1-25	26-50	51-100	101-250	251-500	501-1000	1001+	TOTAL
URBAN	81-100%	27	33	120	656	4,101	8,045	1,266	**14,248**
	61-80%	53	304	844	1,701	4,134	12,804	5,720	**25,560**
	41-60%	56	175	683	3,126	5,806	19,689	8,308	**37,843**
	21-40%	3	59	609	1,703	1,963	9,715	13,540	**27,592**
	0-20%	189	587	2,253	6,541	15,242	34,003	32,129	**90,944**
	TOTAL	**328**	**1,158**	**4,509**	**13,727**	**31,246**	**84,256**	**60,963**	**196,187**
RURAL	81-100%	13,363	21,949	41,763	66,984	31,465	14,325	5,105	**194,954**
	61-80%	888	1,331	4,774	16,299	12,233	11,533	4,248	**51,306**
	41-60%	494	1,088	2,891	8,943	11,551	15,661	4,721	**45,349**
	21-40%	66	262	941	4,160	5,755	11,011	5,632	**27,827**
	0-20%	34	164	753	2,992	7,927	3,349	1,034	**16,253**
	TOTAL	**14,845**	**24,794**	**51,122**	**99,378**	**68,931**	**55,879**	**20,740**	**335,689**

Table 3:
Number of schools in schools of various sizes by categories of income and rurality

	% low income	Students / school 1-25	26-50	51-100	101-250	251-500	501-1000	1001+	TOTAL
URBAN	81-100%	2	1	2	4	11	12	1	**33**
	61-80%	3	7	12	11	13	18	5	**69**
	41-60%	5	5	10	19	17	27	6	**89**
	21-40%	1	2	8	11	5	13	10	**50**
	0-20%	12	15	30	41	44	47	26	**215**
	TOTAL	**23**	**30**	**62**	**86**	**90**	**117**	**48**	**456**
RURAL	81-100%	868	580	642	479	98	22	4	**2693**
	61-80%	58	36	70	106	39	18	3	**330**
	41-60%	31	30	40	57	34	21	4	**217**
	21-40%	5	6	12	25	17	17	5	**87**
	0-20%	3	4	10	17	24	6	1	**65**
	TOTAL	**965**	**656**	**774**	**684**	**212**	**84**	**17**	**3392**

There are too many divisions of the data in these two tables to allow them to be represented in three-dimensional graphics, but a careful consideration of the numbers points out several additional interesting facts:

- While there are more than 7 times as many rural schools as urban schools, there are less than twice as many rural students as urban students.
- By considering the figures for various levels of reported low incomes (rows and row totals), we can see that the largest proportions of both urban students (46% of the urban total) and urban schools (47% of the urban total) occur in areas with 0-20% of reported low incomes; 41% of all urban students, and 25% of all urban schools, are found in the categories of schools with more than 250 students within this 0-20% low-income group.
- In the case of rural schools, a similar analysis shows us that there is a symmetrical concentration of students and numbers of schools in the 81-100% low-income level in schools of 250 students or less. Almost 80% of all rural students, and slightly less than 60% of all rural schools, are found in the 81-100% low income group; three-quarters of all rural students, and slightly more than 40% of all rural schools, and are found in the columns corresponding to schools with 250 or less students within this group.
- An especially interesting case occurs in the single cell corresponding to rural schools with 25 or less students in the 81-100% low income group – the slightly more than one-quarter of all rural schools in this category hold less than 4% of all rural students (at a national level, almost 23% of all primary schools are in rural areas with the highest level of low incomes and 25 or less students; these schools educate slightly more than 2.5% of all students in the country). These and schools in adjacent cells in the same row are responsible for the enormous peak in the number of schools shown in the 81-100% rural / 81-100% low-income portion of Figure 5; we have now gained an idea of how small the schools involved are (and, by inference from the population density figures represented in Figure 3, how widely dispersed they are).

V. Student performance

A. Introduction

We would like to analyze the results of the educational processes carried out in the schools that were described in the last section. We are interested in particular in the results of training in mathematics, science, and computer and Internet use, but we must consider the results of education in all course areas to have a comparative basis for our analysis.

In the best of all possible worlds, we would have a number of independent indicators of the actual skills and knowledge that students acquire at each stage in the educational process. In reality, what we have is two related sets of data about pass/fail rates in primary school:

- MEP data for the year 2001 about the number of students in most public schools who passed each of the four major subjects in the MEP curriculum – Spanish, social studies, science and mathematics – categorized by school, grade, and sex of student.
- MEP data from the year 2002 about the number of students who passed the special 6th grade exams in the same four subjects. This gives us a second look (in addition to standard 6th grade grades) at the learning level of students in different areas as they reach the end of primary education, but has the disadvantage of coming from a year later than our standard grade data (it is the students who passed the 5th grade in 2001 that took the 6th grade special exams in 2002).

Both sets of data allow us to calculate overall pass/fail rates for each subject, for each sex, in each grade (6th grade only, in the case of the MEP special exams), for each school. Such figures are extremely useful, but we must remember the level of precision of the data when we compare different groups – a more powerful type of analysis would be possible if we had the actual grades for each student in each subject, allowing us to calculate average grades in each subject in each school, rather than simple proportions of students in each school who did or did not pass a certain subject.

Other subjects are also taught in the primary curriculum – religion, music, plastic arts, and so on – but only one of these needs further mention here. Computer and Internet training in Costa Rican public schools is not offered as a subject which students pass or fail in itself, but rather as a tool to improve learning in all subjects; there are therefore no grades in this area to be analyzed, although we do present some indirect evidence on the impact of such training on student performance in other subjects in Section VI.

Finally, we have stated that we are interested in *trajectories* of students through the educational process – how they move from one educational stage to the next. Quite obviously, the best way to do this is to actually follow groups, or “cohorts”, of students through time. We do not have this kind of multi-year information, and must instead limit ourselves to observing performance in different subjects in different grades in the same year, from which we may make limited inferences about how performance of groups of students taking certain subjects may vary through time (that is, as they pass from grade to grade).

B. Analysis of failure rates

1. National summary

We will begin with the data in Table 4, which presents the percentages of students of each sex in each grade for the entire country that did not pass a given subject in the 2001 school year. We used percentages of students who did not pass, rather than percentages of those who did, primarily in order to make the numbers in this and succeeding tables easier to interpret and compare; the percentages of students that *did* pass can be calculated by simply subtracting each of the numbers in Table 4 and succeeding tables from 100%.

The basic data are the figures for females and males in grades 1-6 for each of the four main subjects; the "total" column gives an overall figure for the percentage of students of a given sex in a given grade that did not pass, for all subjects; the rows labeled "1-6" show the percentage of students of a given sex that did not pass a given subject, for all grades. The section labeled "both sexes" gives corresponding figures for all students, regardless of sex.

Table 4:
Percentages of students who did not pass given subjects in the 2001 school year

	grade	**Math**	**Spanish**	**Social Studies**	**Science**	**Total**
Girls	**1**	13.10%	12.37%	10.89%	10.93%	11.82%
	2	7.70%	6.23%	6.23%	6.22%	6.60%
	3	8.12%	5.04%	5.25%	5.09%	5.87%
	4	10.44%	5.47%	6.82%	6.45%	7.30%
	5	10.30%	4.09%	5.58%	4.76%	6.18%
	6	6.41%	0.22%	1.31%	0.49%	2.11%
	1-6	9.42%	5.74%	6.15%	5.80%	6.78%
Boys	**1**	15.65%	15.34%	13.66%	13.60%	14.56%
	2	9.84%	8.79%	8.63%	8.50%	8.94%
	3	10.44%	7.43%	7.40%	7.06%	8.08%
	4	14.40%	9.13%	10.05%	9.83%	10.85%
	5	13.43%	6.82%	8.15%	7.07%	8.87%
	6	6.12%	0.37%	1.13%	0.49%	2.03%
	1-6	11.82%	8.28%	8.42%	8.02%	9.14%
Both sexes	**1**	14.43%	13.91%	12.33%	12.32%	13.25%
	2	8.81%	7.56%	7.48%	7.40%	7.81%
	3	9.32%	6.27%	6.36%	6.10%	7.01%
	4	12.49%	7.36%	8.49%	8.20%	9.13%
	5	11.91%	5.50%	6.91%	5.95%	7.57%
	6	6.26%	0.30%	1.22%	0.49%	2.07%
	1-6	10.66%	7.04%	7.32%	6.95%	7.99%
MEP 6th gr.	**6**	6.60%	0.37%	2.44%	3.59%	3.27%

The last row in the table gives the percentages of students who did not pass the special 6th grade MEP exams; these data are included for comparative purposes, but, as we mentioned previously, come from the year 2002; in addition, there was no information on the sexes of the students who did or did not pass each of the subjects in these exams.

We can immediately see that girls passed more frequently than boys in all subjects in all grades, with the exception of very small differences in 6th-grade mathematics and social sciences. We can also see that the failure rates tended to be highest for both sexes in the first grade, fell sharply in 2nd and 3rd grades, and then rose once again in the 4th grade. Two final facts are especially interesting -- with the exception of mathematics, almost all boys and girls passed 6th grade subjects, and mathematics was consistently the subject with the highest failure rates, while the rates for other subjects tended to closely resemble each other.

The sharp rise in the percentage of students passing all 6th-grade subjects was constant even when we controlled for factors such as school size, rurality, and district income levels. One of the possible explanations for this trend suggested by various sources is that teachers were reluctant to fail students at the point at which they were ready to pass from primary to secondary education; we will mention this point again in other sections of this document. The consistently higher failure rates for mathematics is entirely consistent with the current public debate over the perceived low quality of teaching in this area, and, to the degree that quantitative skills are key element in the formation of human resources for a knowledge economy, represents a serious problem for the future competitivity of the country.

2. Factors influencing failure rates

In the previous section on the distribution of the Costa Rican population and its primary schools, we used information about prevalence of lower incomes in different areas of the country, and whether or not schools primary schools in these areas were rural or urban. Using this same kind of information when considering failure rates gives us very useful insights into possible causes of variation in these rates, and, by inference, into the factors that determine the quality of primary school education for boys and girls in different grades. In what follows, we will construct tables of failure rates for different groups of schools and compare the results for these groups, an approach which gives us a good deal of useful information.

a. Income levels and rurality

We will begin with an evaluation of the impact of incomes on failure rates. Using the same income variable that we computed and used in Section 4, we divided the population of schools into five groups (0-20% low incomes … 81-100% low incomes), and then computed failure rates for each of these groups for the most basic variables shown in Table 4 (all combinations of two sexes, four subjects, and six grades – 48 values in all – plus the values for the four 6th-grade MEP exams). The results are presented in Table 5, on the next page.

The interpretation of Table 5 can be made clear by giving an example. We can see that the highest percentage of girls in schools within a single income group failing first-grade mathematics was 15.97%, while the lowest percentage was 8.25%; the difference between the two extremes is 7.72%, which can be regarded as a rough indicator of the effect of variation in district incomes on the frequency with which first-grade girls pass mathematics.

Table 5:
Influence of local income on failure rates
("F1"="female, first grade", "M1"="Male, first grade", etc.)

	Maximum				Minimum				Difference			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	15.97%	15.22%	13.56%	13.52%	8.25%	7.60%	6.73%	6.81%	7.72%	7.62%	6.84%	6.70%
F2	9.94%	8.32%	8.27%	8.27%	4.67%	3.33%	3.39%	3.29%	5.27%	5.00%	4.88%	4.98%
F3	9.68%	6.33%	6.58%	6.46%	5.40%	3.12%	3.31%	3.00%	4.28%	3.21%	3.27%	3.46%
F4	11.32%	6.48%	7.45%	7.21%	9.08%	4.25%	5.56%	5.13%	2.24%	2.23%	1.89%	2.08%
F5	11.01%	4.68%	6.30%	5.45%	9.53%	3.09%	4.74%	3.72%	1.48%	1.60%	1.56%	1.72%
F6	8.61%	0.32%	1.91%	0.84%	4.04%	0.02%	0.64%	0.16%	4.57%	0.29%	1.27%	0.68%
M1	19.59%	19.31%	17.29%	17.18%	9.03%	8.88%	8.08%	7.98%	10.56%	10.43%	9.22%	9.19%
M2	12.63%	11.62%	11.39%	11.17%	5.31%	4.16%	4.09%	3.97%	7.32%	7.46%	7.30%	7.21%
M3	12.40%	9.36%	9.34%	8.97%	7.29%	4.33%	4.44%	4.00%	5.11%	5.03%	4.90%	4.98%
M4	15.77%	10.69%	11.23%	11.17%	12.33%	6.85%	7.95%	7.98%	3.44%	3.84%	3.28%	3.19%
M5	14.12%	7.67%	9.55%	8.05%	12.98%	5.06%	6.66%	5.36%	1.13%	2.62%	2.88%	2.69%
M6	8.61%	0.56%	1.70%	0.77%	3.46%	0.10%	0.56%	0.10%	5.15%	0.47%	1.14%	0.67%
MEP6	10.40%	0.94%	3.76%	5.49%	3.46%	0.02%	0.84%	2.14%	6.94%	0.92%	2.92%	3.35%

In this particular case, and in all other cases in which the figure in the "difference" section of Table 5 is underlined, when we looked at the relationship between the order of income categories and the rank of the corresponding failure rates we found that the income-failure rate relationship was perfect – the highest average failure rate belonged to the 81-100% low-income group, the next highest belonged to the 61-80% low-income group, and so on successively until we arrive at the lowest failure rate, which belongs to the 0-20% low-income group. Since Costa Rican primary education is divided into the "First Cycle" (grades 1-3) and "Second Cycle" (grades 4-6), we can say that the effects of variation in local income levels are especially direct in the First Cycle, and somewhat less so in the Second Cycle.

There are several other interesting patterns in the data in this table:

- The same lower failure rates for females compared to males that we saw in the national figures in Table 4 occurs in both the maximum and minimum sections of the table, with the exception of several figures for the sixth grade.
- We also see the same pattern of relatively high 1st-grade failure rates, dropping in the second and third grade, rising again in the fourth grade, and becoming extremely low in the sixth grade, with the exception of 6th-grade mathematics.

- The *differences* between highest and lowest failure rates, on the other hand, uniformly decrease from first grade on for each subject, with the exception of a sharp increase in the difference between of 6th grade mathematics failure rates for both females and males, which are among the cases in which variations in failure rates are perfectly related to variations in income level.

Based on the decreasing differences between minimum and maximum failure rates, and on the very high percentage of perfect relationships between income ranks and failure rates in earlier years, we conclude that *economic conditions have an effect on failure rates, that this effect is strongest in the first three (for girls) or four (for boys) grades of primary school, and that they continue to affect failure rates in mathematics in the sixth grade, by which time all other differences between income groups have effectively disappeared.*

The second principal factor that we considered in Section 4 was whether schools were rural or urban, as indicated in data supplied by the MEP. Table 6 presents failure rates for urban and rural schools in the same format as that of Table 5.

Table 6:
Influence of rurality on failure rates

	Maximum				**Minimum**				**Difference**			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	14.70%	13.95%	12.36%	12.46%	10.21%	9.51%	8.23%	8.17%	4.48%	4.43%	4.13%	4.30%
F2	8.91%	7.42%	7.36%	7.41%	5.63%	4.20%	4.30%	4.17%	3.29%	3.22%	3.06%	3.24%
F3	8.72%	5.53%	5.81%	5.69%	7.13%	4.24%	4.30%	4.10%	1.59%	1.28%	1.51%	1.59%
F4	11.04%	6.18%	7.40%	7.04%	9.50%	4.34%	5.90%	5.52%	1.54%	1.83%	1.50%	1.52%
F5	10.35%	4.28%	5.65%	4.98%	10.26%	3.81%	5.50%	4.42%	0.08%	0.47%	0.15%	0.57%
F6	7.58%	0.22%	1.54%	0.52%	4.79%	0.21%	0.99%	0.45%	2.79%	0.01%	0.54%	0.08%
M1	17.71%	17.38%	15.49%	15.49%	11.82%	11.52%	10.22%	10.06%	5.89%	5.85%	5.27%	5.43%
M2	11.27%	10.30%	10.11%	9.99%	7.31%	6.10%	5.98%	5.85%	3.96%	4.21%	4.13%	4.14%
M3	11.36%	8.37%	8.33%	8.06%	8.87%	5.82%	5.81%	5.35%	2.50%	2.55%	2.52%	2.70%
M4	14.98%	9.91%	10.79%	10.55%	13.49%	7.87%	8.86%	8.68%	1.49%	2.04%	1.94%	1.86%
M5	13.87%	6.96%	8.27%	7.41%	13.16%	6.61%	7.99%	6.57%	0.72%	0.35%	0.28%	0.83%
M6	7.38%	0.40%	1.27%	0.57%	4.27%	0.33%	0.93%	0.38%	3.11%	0.06%	0.34%	0.19%
MEP6	7.98%	0.54%	2.64%	4.36%	4.68%	0.14%	2.17%	2.56%	3.29%	0.40%	0.47%	1.79%

The differences between maximum and minimum failure rates are generally less than those shown between income groups in Table 5, and we can therefore say that at first glance the impact of rurality on failure rates seems to be less than that of low incomes. However, we see the same patterns in terms of sex (lower female failure rates) and grade (decreasing until 4th grade, very low in 6th grade except for mathematics). The outstanding feature of this table is that with the exception of 5th-grade mathematics for each sex, *all of the minimum failure rates are from urban schools*. This finding is especially interesting in light of the fact that almost 90% of the primary schools in the country were classified as “rural” by the MEP in 2001.

We next considered the combined effects of local economic conditions and urbanization on pass rates (see Tables F and G in the Appendix for the distribution of schools and students according to income and rurality, and note the large number of urban schools in the wealthiest areas). The simplest possible summary of our major findings is presented in Table 7, below, which indicates for each combination of grade, sex, subject, and percentage of low incomes whether the lowest failure rates were found in urban areas (indicated with a "+") or rural areas (without a "+").

Table 7:
Combined influence of local income and rurality on failure rates
(MA=math, SP=Spanish, SS=Social Studies, SC=Science)

	% low incomes																			
	81-100%				**61-80%**				**41-60%**				**21-40%**				**0-20%**			
	MA	SP	SS	SC	MA	SP	SS	SC	MA	SP	SS	SC	MA	SP	SS	SC	MA	SP	SS	SC
F1	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F3							+						+	+	+	+				+
F4	+	+	+	+	+	+	+	+		+	+		+	+				+	+	+
F5		+	+		+		+	+	+			+								
F6	+				+	+			+				+	+	+	+		+		+
M1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
M2	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+
M3						+	+	+	+	+		+	+	+	+	+	+	+	+	+
M4	+						+	+	+	+	+	+		+	+	+		+		
M5							+		+						+	+				
M6	+				+				+						+	+	+	+		+
MEP6	+	+	+	+			+	+			+	+	+	+	+	+	+			

Instead of finding that urban schools universally produced the lowest failure rates, as suggested by Table 6, or that the number of cases in which urban schools had the lowest failure rates increased in all areas as income levels increased (and the percentage of urban schools increased), we found a situation that far more strongly resembled the results of Table 5, with relationships being most strongly marked across all income levels in lower grades. This is, in fact, a reasonable outcome – if failure rates in lower grades are more affected by local income that those of higher grades (which implies that wealthier areas will have lower failure rates in lower grades), and the number of urban schools is strongly related to that same local income level, then we should see more urban schools with low failure rates in earlier grades.

In specific terms, Table 7 shows that (with two exceptions) urban schools have the lowest failure rates for both sexes in all subjects in the first and second grades, and that urban schools are increasingly less represented in the table in later grades, although urban schools still produce the majority of lowest failure rates for girls in the fourth grade, and almost all of the lowest failure rates for boys in the third grade outside the 81-100% low-income category.

b. Sector

We have not previously considered whether primary schools are in the public or private sector. Slightly more than 6% of the schools represented in the MEP data for 2001 for which we have the necessary information are private schools, and their distribution with respect to percentages of low incomes and rurality is shown in Table 8, below. We can form an idea of the relative frequency of private schools by standardizing the numbers of private schools in each income-rurality category by the number of students in that category using data from Table F in the Appendix; having done so, we can see that private schools are relatively more frequent in urban areas than in rural ones, and relatively more frequent in wealthier areas than in poorer ones, as popular conceptions of private schools would suggest.

Table 8:
Distribution of public and private schools by local income and geographical zone

	Urban		**Rural**		**Private schools / 10.000 students**	
(% low income)	**Public**	**Private**	**Public**	**Private**	**Urban**	**Rural**
81-100%	33	--	2677	17	--	0.9
61-80%	55	15	317	13	5.7	2.5
41-60%	58	24	198	20	6.3	4.4
21-40%	31	18	74	12	6.5	4.3
0-20%	106	102	51	15	11.2	9.2

Table 9 contains the comparative data for failure rates in public and private primary schools in our standard format. The outstanding characteristic of the data is that *all* of the lowest failure rates – all of the data in the "minimum" section of the table – comes from private schools. The values of the figures in the "difference" section of the table, which we have been using as an indicator of the impact of a factor on pass rates, are very high, due mostly to the extremely low failure rates in private schools.

Table 9:
Influence of sector on failure rates

	Maximum *(Public schools)*				**Minimum** *(Private schools)*				**Difference**			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	13.97%	13.23%	11.67%	11.72%	1.99%	1.41%	0.93%	0.96%	11.98%	11.82%	10.74%	10.75%
F2	8.15%	6.64%	6.64%	6.63%	1.84%	0.94%	0.90%	0.84%	6.31%	5.70%	5.74%	5.80%
F3	8.55%	5.35%	5.59%	5.42%	2.80%	1.25%	0.91%	0.98%	5.75%	4.10%	4.68%	4.44%
F4	10.98%	5.82%	7.24%	6.85%	3.53%	0.85%	1.12%	1.12%	7.44%	4.97%	6.12%	5.73%
F5	10.76%	4.30%	5.90%	5.02%	4.50%	1.43%	1.53%	1.46%	6.26%	2.88%	4.37%	3.55%
F6	6.90%	0.23%	1.40%	0.52%	0.46%	0.11%	0.21%	0.11%	6.44%	0.12%	1.19%	0.42%
M1	16.65%	16.33%	14.54%	14.48%	1.85%	1.50%	1.21%	1.31%	14.80%	14.83%	13.33%	13.17%
M2	10.45%	9.36%	9.19%	9.06%	1.50%	0.83%	0.76%	0.70%	8.95%	8.53%	8.43%	8.36%
M3	11.01%	7.87%	7.83%	7.49%	2.80%	1.42%	1.52%	1.05%	8.20%	6.45%	6.31%	6.45%
M4	15.07%	9.67%	10.61%	10.40%	4.97%	1.58%	2.02%	1.85%	10.10%	8.10%	8.59%	8.55%
M5	13.97%	7.18%	8.58%	7.46%	6.13%	1.94%	2.32%	1.87%	7.84%	5.24%	6.26%	5.59%
M6	6.53%	0.39%	1.21%	0.52%	0.88%	0.18%	0.15%	0.11%	5.65%	0.20%	1.06%	0.41%
MEP6	7.09%	0.39%	2.63%	3.89%	0.92%	0.20%	0.27%	0.23%	6.17%	0.19%	2.36%	3.66%

In fact, the private schools show very little evidence of the pattern we have seen in other tables – high 1^{st}-grade failure rates, relatively high 4^{th}-grade failure rates, relatively strong differences between male and female performance, and so on. We do see a very interesting trend towards increasing failure rates in mathematics for both sexes in successive grades in private schools, which suddenly disappears in 6^{th} grade; either mathematics teaching improves suddenly in that year, or we have found another indirect indicator of a reluctance to fail students at the point where they pass from primary to secondary education.

When we analyzed the these same figures controlling for income levels, we still found that private schools almost universally failed less students than did public schools – of 260 comparisons (52 grades in each of 5 income groups), only 11 showed that public schools had lower failure rates, and 8 of these situations occurred in the 6^{th} grade, where almost all students passed in both public and private schools, and the differences between the sectors were very small.

This same result held when we analyzed the public-private dichotomy controlling for rural and urban schools – of 104 comparisons (52 grades each for urban and rural schools) only two showed public schools with lower failure rates, both in 6^{th} grade (MEP 6^{th} grade Spanish exams in urban areas, and female 6^{th} grade Spanish in rural areas). In the final analysis, controlling simultaneously for both income levels and the rural-urban dichotomy, we made 468 comparisons (there were no private schools in the 81-100% low-income level), and found only 18 cases in which public schools had lower failure rates – 13 of them in the 6^{th} grade.

It would be natural to conclude from this that education in private schools is “better” than education in public schools, and in fact we must conclude that in terms of chances of passing different courses, being in a private school is an advantage to students. However, as we mentioned previously, we must remember that we are measuring the percentage of students that are passing certain courses or not; this does not give us any indication of the exact grades of students in different groups, but simply the number of students that achieved certain minimum standards. Our findings would be easier to interpret if we had more precise information about the performance of individual students.

In addition, the relationship between passing a course and actually achieving a certain competence in the material being taught is not necessarily perfect. As stated previously, it would be far better for the purposes of our analysis if we had independent indicators of the transfer of knowledge to students; the 6^{th}-grade MEP exams are a possible source of such information, but the fact that the failure rates for these exams are consistently among the lowest under any combination of circumstances we have considered leads us to treat this line of evidence with caution.

c. Teachers

In this section we will consider the influence on student failure rates of the professional qualifications of teachers, the number of teachers, and the number of students per teacher. As usual, we need to think carefully about the ability of our data to support such analysis, and carefully define the areas in which the data can be used to draw useful conclusions.

i. Professional qualifications

We would obviously like to have information about the degree to which teachers truly understand the materials they are teaching, and their ability to transmit this knowledge to students. We do not have direct information in these areas, and must use an indirect indicator of these factors – the civil service ranks of the teachers.

Although the relationship between academic degrees and civil service ranks is not perfect, the MEP ranks for teachers can be approximately divided into three groups – the lowest of which includes teachers who have not yet received an academic degree in teaching or a related area, a second group which includes teachers who have received or are about to receive such academic degrees up to the level of bachillerato, and a third group that has obtained academic degrees at the level of licenciado or higher.

To the degree that this increased professional training results in more effective teachers, teachers with increasing civil service rankings should be more likely to produce students that better understand the materials being taught, and therefore to have less students that fail courses. In what follows, we will categorize teachers as belonging to one or another of these three levels, and analyze failure rates associated with each of these types of teachers.

However, our data does not allow us to easily relate particular teachers (with particular civil service ranks) to particular pass rates; in particular, when we consider a school with teachers with different civil service ranks, we have no way of evaluating the contribution of each civil service rank to the overall pass rates of the school. After considering and rejecting a number of methods to compute weighted averages for teacher qualifications for entire schools, we instead turned to a consideration of cases in which all teachers have the same civil service rank.

We found that more than 85% (1953 of 2287) of schools whose teachers all had the same civil service rank were concentrated in the category of rural public schools in areas with 81-100% low incomes. We decided that comparing the average failure rates of these 1953 schools to those of the other 334 schools, distributed among all other possible combinations of rurality, income level, and sector, would be misleading – we would, for example, be comparing average pass rates of 5 *urban* public schools in the 81-100% low-income category to the average rates of 1953 *rural* public schools in the same income category.

Instead, we limited ourselves to comparisons made within the single category of rural public schools in the 81-100% low-income category. This gives us more comparable numbers of schools in each category (127 schools with all non-degree teachers, 1378 with all teachers with degrees up to the level of bachillerato, and 448 schools with all teachers with degrees at the level of licenciatura or higher), and, in fact, includes almost exactly half of all primary schools in the country (1953 of 3854) for which we have information about district income level, sector and rurality.

We were also pleased to see that our initial worry that more highly-qualified teachers would be relatively scarce in poorer rural areas was not confirmed by the data. The proportions of schools in our sample with teachers at successively higher levels of professional qualification (6.5%, 70.56%, and 22.94%, respectively) are almost exactly the same as the proportions of teachers at each level in the entire country in the year 2001 (3.64%, 69.54%, and 26.29%), reflecting the fact that our sample does indeed include a very large portion of all schools in the country.

Since we are considering a pure case in which differences in sector, rurality, and income levels are controlled for, the proportion of teachers with different professional qualifications reflects the national proportions so exactly, and the sample size is so large, the results of our comparisons should give us some information which will be useful in making inferences the impact of professional qualifications on pass rates in more complex, multi-teacher situations. The results of our comparisons are presented in the usual format in Table 10.

Table 10:
Influence of teacher qualifications of failure rates

	Maximum				**Minimum**				**Difference**			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	20.11%	20.11%	19.84%	19.84%	14.12%	13.44%	11.88%	11.67%	5.99%	6.66%	7.96%	8.17%
F2	21.98%	19.78%	19.41%	20.15%	9.81%	8.20%	7.86%	7.80%	12.16%	11.58%	11.56%	12.35%
F3	16.16%	11.79%	10.92%	10.48%	8.42%	5.14%	5.47%	5.31%	7.73%	6.65%	5.45%	5.17%
F4	10.72%	6.48%	7.07%	7.01%	8.06%	5.91%	5.91%	5.91%	2.66%	0.56%	1.15%	1.10%
F5	10.01%	5.67%	6.38%	5.67%	8.41%	4.33%	5.22%	4.82%	1.60%	1.34%	1.16%	0.85%
F6	13.74%	0.76%	1.61%	0.84%	4.70%	0.21%	0.76%	0.00%	9.05%	0.55%	0.85%	0.84%
M1	21.75%	21.52%	19.73%	21.08%	19.13%	19.04%	16.77%	16.73%	2.62%	2.49%	2.96%	4.35%
M2	16.08%	15.79%	15.50%	15.79%	11.03%	10.18%	9.84%	9.84%	5.05%	5.60%	5.66%	5.95%
M3	11.88%	9.23%	9.21%	8.75%	10.49%	8.24%	7.12%	7.87%	1.39%	0.99%	2.09%	0.88%
M4	14.00%	10.16%	10.48%	10.09%	10.55%	9.17%	9.17%	10.03%	3.45%	0.98%	1.30%	0.06%
M5	11.22%	7.85%	8.38%	7.27%	9.42%	6.40%	6.91%	6.51%	1.80%	1.46%	1.47%	0.76%
M6	14.91%	2.48%	6.83%	0.78%	5.58%	0.45%	1.04%	0.62%	9.33%	2.03%	5.79%	0.16%
MEP6	14.66%	8.79%	10.05%	9.03%	5.75%	1.03%	1.79%	3.40%	8.90%	7.76%	8.25%	5.63%

The failure rates in the 1st and 2nd grades for both girls and boys are high relative to figures in similar tables in this document, and we see for the first time relatively high failure rates in the MEP 6th grade exams (in the "maximum" section of the table). On the other hand, the figures in the "difference" section of the table that we have been using as crude indicators of the impact of variation in critical factors are not especially high compared to those in other tables, with the exception of all subjects for 2nd grade girls.

Within the table, however, we see that the largest differences seem to be concentrated in the First Cycle (grades 1-3) of primary education for girls (with the exception of 6th grade mathematics), the first two grades, and especially 2nd grade, for boys (with the exception of 6th grade mathematics and social sciences), and all subjects in the MEP 6th grade exams.

This pattern assumed greater significance when we analyzed the relationship between the professional qualifications of the teachers and failure rates. Those cases in which there was a perfect relationship between these factors (highest failure rates in schools with non-degree teachers, intermediate rates in schools with teachers with degrees to the bachillerato level, and lowest in schools with teachers with licentiaturas or higher) are underlined in Table 10. We can see that these perfect relationships occur in almost all subjects in the First Academic Cycle, in addition to two subjects each in the 5th and 6th grades (including an especially high difference in the case of 6th grade mathematics); in the case of boys they are universal in the first two grades, are almost universal in 6th grade (again including a relatively high figure for 6th grade mathematics), and also occur twice in the 5th grade. They also occur in the MEP 6th grade exams for all subjects.

The relatively high values for differences between maximum and minimum failure rates in lower grades, the correlation of these high differences with perfect relationships between professional qualifications of teachers and average pass rates, and the similarity of this pattern to those seen in discussions of the effect of income level (see Table 5 and associated discussion) and the interaction between rurality and school sector (see Table 7 and associated discussion) lead us to conclude that *we are once again seeing that the performance of students in early grades is especially sensitive to variation in critical factors, in this case the training of their teachers.* Finally, we note that the high sensitivity of 6th grade mathematics scores to teacher qualification is especially relevant to our emphasis on science and mathematics training, and that for the first time we seem to have isolated a factor that is important in determining student performance in MEP 6th grade exams.

ii. Single-teacher schools

In discussions of Costa Rican primary education, a great deal of attention is often given to the large number of schools with a single teacher. The basic information that we received from various sources that could be used to identify such schools and analyze their performance was inconsistent to varying degrees – we might find a school classed as “single-teacher”, for instance, that was also recorded to have more than one teacher, even after accounting for the existence of non-teaching administrative staff that held a civil service rank. We also found cases in which two independent sources disagreed on which schools were single-teacher, even though both sources had a specific variable to record this attribute.

In arriving at a satisfactory classification of schools into single-teacher and not, we made extensive use of information from the 2002 school year supplied by the MEP which indicated the total number of civil service staff in primary schools, and the number of those staff members which were actually teaching students; comparing the number of schools with a single true educator to indicators of information about numbers of teachers in the 2001 school year, and eliminating from the analysis those schools for which estimates of numbers of teachers were grossly inconsistent, we estimated that there were 1660 single-teacher primary schools in the year 2001.

As we expected, the overwhelming majority of these schools (almost 90%) were rural public schools in the 81-100% low-income category, which includes a total of 2677 schools for which we have all necessary information. Facing the same problems in comparing very large numbers of one type of school to very small numbers of other types of schools that we discussed in the introduction to the previous section, we adapted the same strategy of limiting our comparisons to rural public schools in the lowest-income areas, and compared 1462 single-teacher schools within this group to 1211 schools in the same group which had more than one teacher. The initial results of this comparison are given in Table 11, on the next page.

Table 11:
Single-teacher vs. multiple-teacher schools: failure rates

	Maximum				Minimum				Difference			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	16.50%	15.53%	13.60%	13.65%	14.38%	14.23%	13.32%	13.24%	2.12%	1.30%	0.28%	0.40%
F2	10.34%	8.60%	8.57%	8.58%	9.52%	8.19%	7.97%	7.88%	0.82%	0.42%	0.60%	0.70%
F3	9.81%	6.40%	6.64%	6.50%	8.88%	5.91%	6.28%	6.22%	0.94%	0.49%	0.36%	0.28%
F4	12.25%	6.87%	7.71%	7.56%	9.68%	6.02%	6.60%	6.69%	2.57%	0.85%	1.11%	0.87%
F5	11.31%	5.05%	6.49%	5.65%	7.68%	3.82%	4.54%	4.47%	3.63%	1.22%	1.95%	1.18%
F6	9.45%	0.26%	1.98%	0.66%	6.32%	0.25%	1.19%	0.65%	3.13%	0.01%	0.80%	0.01%
M1	20.25%	19.90%	17.65%	17.53%	18.59%	18.35%	16.97%	16.86%	1.66%	1.54%	0.67%	0.67%
M2	13.06%	11.93%	11.71%	11.52%	11.64%	10.88%	10.49%	10.41%	1.42%	1.05%	1.23%	1.11%
M3	12.63%	9.69%	9.62%	9.20%	11.27%	8.17%	8.17%	7.98%	1.36%	1.52%	1.46%	1.21%
M4	16.51%	10.88%	11.65%	11.49%	13.48%	9.81%	9.81%	9.83%	3.03%	1.08%	1.84%	1.66%
M5	14.49%	8.19%	9.46%	8.73%	8.95%	5.49%	5.93%	5.64%	5.54%	2.70%	3.53%	3.10%
M6	9.43%	0.65%	1.69%	0.80%	6.16%	0.48%	1.34%	0.65%	3.27%	0.17%	0.35%	0.14%
MEP6	11.63%	1.13%	4.36%	6.12%	7.71%	0.92%	3.73%	4.13%	3.92%	0.21%	0.63%	1.99%

In all cases except those of 6th grade Spanish for boys and the MEP 6th grade exams for Spanish and social studies, the lowest failure rates were found in single-teacher schools. Even though the differences between groups are relatively low, this result was still surprising given our preconception that that single-teacher schools were exposed to more challenges to maintain teaching excellence that any other segment of the formal educational system. However, the result held firm even when we controlled for levels of professional qualification of teachers, and we must conclude that *being in a one-teacher school does not by itself decrease the chances of students to pass courses* (nor is it necessarily much of an advantage, given the small differences in Table 11*); it is rather the environment in which the great majority of such schools are found – low-income rural areas – that negatively affects the educational experience.*

iii. Student-teacher ratios

The number of students that teachers instruct in the classroom is commonly regarded as an important factor in determining the quality of education. We began our analysis of the effects of variations in this factor by assigning each school in our data to one of three student-teacher ratio categories – 1-20 students per teacher ("low"), 21-40 students per teacher ("medium"), and more than 40 students per teacher ("high").

We next investigated the distribution of primary schools with respect to student-teacher ratios, income levels, rurality, and sector. We found that we could not investigate the combined effect of student-teacher ratios and differences between public and private schools, since only 15 of 236 private schools had more than 20 students per teacher – effectively, there was no variation in student-teacher ratios in private schools. Furthermore, only 10 of 868 urban public schools had more than 40 students per teacher, which made it even more difficult to include the highest category of student-teacher ratios in the full analysis.

We will return to the case of consider this group of public schools with "high" student-teacher ratios in a separate discussion later in this section, but we present below an analysis in our standard format of the effects of differences between "low" and "normal" student-teacher ratios in public schools, later controlling for the effects of income levels and rurality.

Table 12:
Effects of student-teacher ratios on failure rates

	Maximum				Minimum				Difference			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	13.11%	12.35%	10.77%	10.86%	10.12%	9.49%	8.34%	8.31%	2.99%	2.87%	2.43%	2.56%
F2	7.48%	5.99%	5.97%	6.01%	6.05%	4.96%	5.16%	5.09%	1.44%	1.03%	0.81%	0.92%
F3	8.43%	5.14%	5.34%	5.21%	5.97%	3.70%	3.84%	3.82%	2.47%	1.44%	1.50%	1.39%
F4	10.85%	5.40%	7.03%	6.57%	8.09%	4.49%	5.29%	5.15%	2.76%	0.91%	1.75%	1.43%
F5	10.85%	4.27%	6.04%	4.98%	7.89%	3.09%	3.99%	3.58%	2.96%	1.18%	2.05%	1.40%
F6	6.71%	0.20%	1.41%	0.49%	4.89%	0.20%	0.84%	0.32%	1.81%	0.00%	0.57%	0.17%
M1	15.51%	15.32%	13.46%	13.38%	12.19%	11.66%	10.38%	10.49%	3.32%	3.66%	3.07%	2.89%
M2	9.72%	8.57%	8.43%	8.29%	7.65%	7.06%	7.03%	6.84%	2.07%	1.51%	1.40%	1.45%
M3	10.68%	7.47%	7.43%	7.09%	8.01%	5.77%	5.76%	5.47%	2.67%	1.70%	1.67%	1.63%
M4	14.80%	9.11%	10.28%	9.97%	11.63%	7.49%	8.06%	8.16%	3.17%	1.63%	2.22%	1.81%
M5	14.14%	7.07%	8.70%	7.32%	11.04%	5.55%	6.33%	5.75%	3.11%	1.51%	2.37%	1.57%
M6	6.33%	0.41%	1.21%	0.48%	4.35%	0.33%	0.86%	0.34%	1.98%	0.08%	0.35%	0.13%
MEP6	6.80%	0.52%	2.92%	3.61%	4.23%	0.26%	2.04%	2.59%	2.57%	0.25%	0.88%	1.02%

All of the lowest failure rates come from the group of schools with lower (1-20) student-teacher ratios, with the exception of 6th grade Spanish for boys and the MEP 6th grade exams in Spanish and social studies. This indicates that lower student-teacher ratios are advantageous, but the low differences between the highest and lowest failure rates suggest that the advantage is not large. When we controlled for effects of income levels on these findings, the results stayed the same – of 260 comparisons made (5 income levels and 52 basic failure rates), only 18, or less than 7%, of the lower failure rates came from schools with higher student-teacher ratios.

In the final comparison of failure rates controlling for both income levels and rurality, 103 of 520, or almost 20%, of the lowest failure rates came from schools with higher student-teacher ratios; 32 of these cases were concentrated in the single category of urban schools in the lowest-income segment of the sample, and included almost all subjects for both sexes between the third and fifth grades; another 16 of these cases, centered around the fourth and fifth grades for both sexes, were found in the category of rural schools in the second-lowest income group. *In general, we believe that the data support the conclusion that lower student-teacher ratios are an advantage for students.*

Returning to the group of schools with very high student-teacher ratios that were excluded from the previous discussion, we noted the extremely uneven distribution of such cases – of a total of 872 primary schools in the country with "high" student-teacher ratios, 739, or almost 85%, were in the poorest rural areas. Our original assumption that these schools would be the small schools typical of such zones was based on a failure to consider basic arithmetic – having one or two teachers in schools with enrollments of 50 students or less will almost invariably produce a "low" or "normal" student-teacher ratio (which should, disregarding all factors other than the amount of attention that a teacher can give to students, therefore produce higher pass rates). In fact, when we looked at the enrollments of schools in poorer rural areas with high student-teacher ratios, we discovered that almost 90% of them had between 50 and 250 students.

Considering the data in Table 3 on the size distributions of schools in these zones, we can say that *the great majority of schools in the poorest rural areas which have a sufficiently large enrollment for problems in student-teacher ratios to be detected do indeed show such problems.* Even though we have discussed the reasons why we could not include "high" student-teacher ratios in our more general analysis, the data do allow us to perform a very specific comparison of *public* schools in *rural* areas with different student-teacher ratios to help us understand the impact of this situation on failure rates. We will further restrict the analysis to rural public schools are in the *lowest income group* in order to avoid comparing averages from groups of widely varying sizes; this gives us a sample of 936 schools with "low" student-teacher ratios, 997 with "medium" ratios, and 739 with "high" ratios – almost 70% of the schools in the country.

Table 13:
Effects of student-teacher ratios on
failure rates in rural poor areas

	Maximum				**Minimum**				**Difference**			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	16.94%	16.33%	14.86%	14.79%	15.28%	14.32%	12.91%	12.84%	1.67%	2.02%	1.95%	1.95%
F2	11.43%	9.54%	9.37%	9.23%	9.05%	7.95%	7.98%	8.03%	2.39%	1.59%	1.39%	1.19%
F3	10.10%	6.74%	7.14%	6.76%	7.09%	4.88%	5.01%	5.18%	3.02%	1.86%	2.13%	1.58%
F4	12.17%	7.38%	8.07%	8.03%	9.76%	5.99%	6.04%	6.04%	2.41%	1.39%	2.03%	1.99%
F5	11.30%	5.13%	6.78%	5.69%	7.52%	4.07%	4.65%	4.43%	3.78%	1.06%	2.13%	1.26%
F6	9.62%	0.36%	2.01%	0.74%	7.35%	0.19%	1.33%	0.59%	2.26%	0.16%	0.68%	0.14%
M1	20.97%	20.49%	19.04%	18.86%	18.47%	17.96%	16.62%	16.71%	2.50%	2.53%	2.42%	2.15%
M2	13.87%	12.53%	12.08%	12.12%	11.49%	10.94%	10.69%	10.54%	2.38%	1.58%	1.40%	1.58%
M3	12.74%	9.71%	9.69%	9.22%	10.48%	8.70%	8.66%	8.28%	2.26%	1.01%	1.03%	0.94%
M4	16.48%	12.07%	12.11%	12.11%	13.49%	9.43%	9.85%	9.54%	3.00%	2.65%	2.26%	2.57%
M5	14.29%	8.03%	9.59%	8.64%	10.49%	6.41%	6.75%	6.33%	3.80%	1.61%	2.84%	2.31%
M6	9.39%	0.69%	1.88%	0.83%	6.77%	0.48%	1.31%	0.73%	2.62%	0.20%	0.57%	0.10%
MEP6	11.77%	1.64%	4.74%	6.14%	8.43%	0.77%	2.44%	4.34%	3.34%	0.87%	2.31%	1.80%

The differences between highest and lowest failure rates in Table 13 are small, indicating that the general effect of variations in student-teacher ratios is small. When we consider the relationship between the order of student-teacher ratios and the magnitude of failure rates, a familiar picture emerges – the failure rates for all of the subjects in the first four grades for both sexes, with the exception of 1st and 2nd grade social studies for girls and 1st grade science for boys, are perfectly related to student-teacher ratios ("high" ratios with the highest failure rates, "medium" ratios with intermediate failure rates, and "low" ratios with the lowest failure rates). This confirms our earlier conclusion about the importance of lower student-teacher ratios, and once again shows the special sensitivity of students in the academic First Cycle to the effects of many of the factors we have considered.

VI. Access to computers and the Internet

Information and communications technologies form the basic infrastructure of knowledge-based economies, and access to these technologies from childhood on is rapidly becoming a *sine qua non* for effective participation in the modern world. The penetration of computers and the Internet is relatively low in Costa Rica, and lower in homes than in offices; schools are one of the few places where the great majority of young Costa Ricans might have access to these resources. It is therefore extremely important for to have an accurate idea of how far computer and Internet penetration has proceeded in Costa Rican primary schools.

While we do not have any systematic information about access to computers and the Internet in private primary schools, we have good information about such access in public primary schools, thanks to information provided to us by the Fundación Omar Dengo (FOD), the organization in charge of administering computer and Internet training in these schools. The number of private primary schools is so relatively small that either eliminating them from our analysis, or assuming for the sake of argument that all of them have computing programs, will make little difference in our conclusions.

Table 14, on the next page, shows the distribution of primary schools that were active in the FOD program in the year 2001 in terms of geographic zone, school size, and income level. Figures for numbers of students, and the percentage of students affected by the FOD program in each category, give percentages very similar to those of the schools in this particular format.

As the data in Table 14 make clear, student access to computers in public primary schools in 2001 was overwhelmingly concentrated in the largest schools in the country. With a single exception, all schools with more than a thousand students had computer training programs, as did almost 90% of schools with between 501 and 1000 students. This figure drops sharply for schools with between 251 and 500 students, to 28%, after which there was an almost total absence of training in smaller schools – of the 2510 schools with 250 or less students in Table 14, only 78, or slightly more than 3%, had computer training through the FOD.

This distribution clearly reflects the importance of a factor which we have discussed several times previously – it is more economical for a variety of reasons to provide services in a few large schools than in many small ones. In order to serve a maximum of students with limited resources, the most obvious strategy available is to concentrate on large schools, and move into smaller schools as resources become available.

The effects of this situation can be seen in other parts of the information from the FOD. There are two general ways in which computer training can be offered – in computer laboratories, where most students have a chance to use computers on an individual basis, and without computer laboratories, in which case training is done more through lecturing and examples provided by a teacher with a computer, and the amount of time that each student can spend actually using a computer is correspondingly less. The second situation roughly corresponds to the “educational lectures” mode of the FOD, and when we looked at the distribution of the use of computer laboratories and lectures, we discovered that with 6 exceptions out of 78, all training done in schools with less than 100 students was done with lectures, while all training done in FOD schools with more than 100 students was done using computer laboratories. Clearly, the use of lecturing is an attempt to extend access to computers in situations in which the use of computer laboratories is not possible.

Table 14:
Distribution of public schools with computer training

Enrollment size	% low income	FOD schools		% of total schools	
		Urban	**Rural**	**Urban**	**Rural**
1-25	**81-100%**		30		3.46%
	61-80%		1		1.72%
	41-60%				
	21-40%				
	0-20%				
26-50	**81-100%**		25		4.31%
	61-80%	1	1	14.29%	2.78%
	41-60%				
	21-40%		2		33.33%
	0-20%				
51-100	**81-100%**		17		2.65%
	61-80%		1		1.43%
	41-60%				
	21-40%				
	0-20%				
101-250	**81-100%**	1	14	25.00%	2.92%
	61-80%	1	2	9.09%	1.89%
	41-60%	2	1	10.53%	1.75%
	21-40%	1	1	9.09%	4.00%
	0-20%	2	2	4.88%	11.76%
251-500	**81-100%**	6	34	54.55%	34.69%
	61-80%	4	7	30.77%	17.95%
	41-60%	4	11	23.53%	32.35%
	21-40%	2	3	40.00%	17.65%
	0-20%	7	6	15.91%	25.00%
501-1000	**81-100%**	12	19	100.00%	86.36%
	61-80%	18	15	100.00%	83.33%
	41-60%	24	17	88.89%	80.95%
	21-40%	13	14	100.00%	82.35%
	0-20%	40	5	85.11%	83.33%
1001+	**81-100%**	1	4	100.00%	100.00%
	61-80%	5	3	100.00%	100.00%
	41-60%	6	4	100.00%	100.00%
	21-40%	10	5	100.00%	100.00%
	0-20%	25	1	96.15%	100.00%

Comparing the number of schools that were participating in the FOD program in the year 2003 to those that were participating in the program in 2001 shows clearly that the FOD is extending its reach into smaller schools as time passes. While only 12 new computer laboratories were added in schools with between 501 and 1000 students (making coverage in this size of school almost complete), 87, or 84% of all new laboratories, appeared in schools with between 251 and 500 students, and 7 computer laboratories were added in schools of from 101 to 250 students.

The advantages of following this size-oriented strategy can be see in a single fact – with a presence in slightly more than 11% of all public schools in the country in 2001, the FOD had placed computers in schools that contain almost 46% of all the students in the country. We can see no reasonable alternative to this strategy, but we note that the relationship between sizes of schools, rurality and income levels means that those with the least economic resources will be the last to receive the benefits of access to computers. Table 15 illustrates this point.

Table 15:
Percentage of access to computers by district income levels

% low incomes	**Schools**	**Students**
81-100%	5.98%	21.90%
61-80%	14.79%	48.50%
41-60%	22.55%	59.94%
21-40%	31.43%	74.33%
0-20%	37.23%	66.52%

While computers can be used for an almost unlimited number of purposes, the type of computer use that is growing most explosively in importance in knowledge-based societies is that of Internet access. The FOD has actively sought to provide Internet access and training in public primary schools, and we were able to use the information they provided us to investigate the level of such access.

As usual, several points must be born in mind as we consider our results. In the first place, we do not have information about when Internet access became available in particular schools, only (1) whether they had such access in the year 2003 and (2) the year that they began to participate in the FOD program. We will estimate the penetration of Internet access in the year 2001 by assuming that schools with access in 2003 had that access 2 years earlier; to the degree that this assumption is incorrect, our estimates will be inaccurate. This approach does, however, give us a reasonable estimate of the *maximum* penetration of Internet access in the year 2003; more exact data would almost undoubtedly show us that Internet penetration was less than we are estimating.

Table 16 shows us the distribution of schools estimated to have had Internet access in the year 2001. We exclude one rural school with between 1 and 25 students, and one with between 26 and 50 students, in order to make the table more compact; the degree of Internet penetration that they represent in their respective categories is less than one-fifth of one percent.

Table 16:
Access to Internet by income levels, enrollment, and geographical zone

Enrollment size	% low income	FOD schools with Internet		% of total schools	
		Urban	Rural	Urban	Rural
101-250	**81-100%**		2		0.42%
	61-80%		1		0.94%
	41-60%	1		5.26%	
	21-40%		1		4.00%
	0-20%	1	1	2.44%	5.88%
251-500	**81-100%**	5	15	45.45%	15.31%
	61-80%	4	4	30.77%	10.26%
	41-60%	2	4	11.76%	11.76%
	21-40%		1		5.88%
	0-20%	4	4	9.09%	16.67%
501-1000	**81-100%**	5	10	41.67%	45.45%
	61-80%	14	8	77.78%	44.44%
	41-60%	14	9	51.85%	42.86%
	21-40%	11	8	84.62%	47.06%
	0-20%	30	2	63.83%	33.33%
1001+	**81-100%**		1		25.00%
	61-80%	3	2	60.00%	66.67%
	41-60%	4	1	66.67%	25.00%
	21-40%	10	4	100.00%	80.00%
	0-20%	18	1	69.23%	100.00%

Access has been provided to 207 mostly larger schools (less than 5% of all the schools in the country), all with computer laboratories, which contain almost 29% of the country's students. All of the schools that entered into the FOD program between 2001 and 2003 that had Internet connectivity in 2003 had between 251 and 500 students – another indication of the FOD strategy to extend services to smaller schools as resources allow, although the coverage of Internet connectivity in larger schools is still not so nearly complete as was the case for computers.

The figures for computers and Internet access in public primary schools are far higher than those for any other Central American country, but still do not come close to those for more developed countries; 97% of public primary schools in the United States were reported to have Internet access in the year 2000, for instance[10].

Table 17 contains the same type of summary of penetration of Internet access by levels of income and rurality that we presented in Table 15 for the case of computers. As was the case in that table, the relationship between school enrollment size, rurality, and income levels means that a disporportionate number of the poorest schools and students in the country remain without Internet access, and we can see that the very

[10] <nces.ed.gov/pubs2001/internetaccess/figs.asp>

large number of schools in the lowest-income rural group are effectively without Internet access.

Table 17:
Percentage of all schools and students with access to Internet by income levels

% low income	Schools	Students
81-100%	1.47%	8.65%
61-80%	9.02%	32.20%
41-60%	11.44%	32.68%
21-40%	25.55%	59.16%
0-20%	21.79%	48.99%

As a final point, we were interested in investigating the impact of access to computers and training in computer use on the performance of students in different subjects – a subject that was especially interesting in light of the FOD's innovative teaching of computer programming as a tool to develop logical thought and problem solving skills[11].

Table 18:
Failure rates of FOD and non-FOD schools

	Maximum				**Minimum**				**Difference**			
	Math	Span.	Social	Science	Math	Span.	Social	Science	Math	Span.	Social	Science
F1	13.84%	13.11%	11.80%	11.79%	12.12%	11.39%	9.70%	9.81%	1.72%	1.73%	2.09%	1.98%
F2	8.53%	7.05%	7.03%	6.96%	6.69%	5.24%	5.27%	5.31%	1.84%	1.80%	1.77%	1.65%
F3	8.37%	5.27%	5.52%	5.40%	7.83%	4.77%	4.93%	4.72%	0.55%	0.50%	0.59%	0.68%
F4	11.06%	5.64%	7.07%	6.47%	9.91%	5.28%	6.61%	6.43%	1.15%	0.35%	0.46%	0.04%
F5	11.19%	4.19%	5.98%	4.80%	9.45%	3.98%	5.21%	4.71%	1.74%	0.21%	0.77%	0.08%
F6	6.93%	0.22%	1.48%	0.53%	5.89%	0.22%	1.14%	0.44%	1.04%	0.00%	0.35%	0.09%
M1	16.72%	16.32%	14.88%	14.82%	14.24%	14.04%	12.05%	11.98%	2.48%	2.28%	2.83%	2.84%
M2	10.78%	9.79%	9.53%	9.38%	8.67%	7.55%	7.51%	7.40%	2.11%	2.24%	2.03%	1.99%
M3	10.85%	8.02%	8.09%	7.78%	9.94%	6.72%	6.58%	6.19%	0.92%	1.29%	1.51%	1.59%
M4	15.02%	9.35%	10.19%	10.01%	13.85%	8.89%	9.93%	9.68%	1.17%	0.45%	0.26%	0.33%
M5	14.93%	7.03%	8.73%	7.17%	12.05%	6.62%	7.61%	6.98%	2.87%	0.40%	1.12%	0.20%
M6	6.90%	0.41%	1.24%	0.63%	5.29%	0.33%	1.02%	0.34%	1.61%	0.09%	0.22%	0.29%
MEP6	7.62%	0.62%	3.26%	4.28%	5.60%	0.13%	1.60%	2.93%	2.01%	0.50%	1.66%	1.35%

The results of our standard comparison in the case of schools that did and did not participate in the FOD program are presented in Table 18. The differences between maximum and minimum failure rates are very small (and remained small when controlling for income levels), which seems to indicate that computer training has little impact on student performance. It is true, however, that the minimum failure rates for both sexes in all subjects in the First Academic Cycle and 6th grade, as well as all MEP 6th-grade exam scores, come from FOD schools, which does suggest some level of systematic influence of such training.

[11] See <www.fod.ac.cr/programas>

VII. Student and teacher survey results

The results that we have presented to this point have been based on information that was originally gathered for purposes other than those of our own analysis. In this section, we present findings from our own survey of 51 primary schools, involving interviews with 99 teachers and 387 2^{nd}- and 6^{th}-grade students.

A. Information about the schools

To analyze the results of our interviews, we needed to divide the schools into a relatively small number of groups whose comparison might be informative. This section discusses how we arrived at this categorization.

Table 19 presents the distribution of our sample in terms of the same categories we have used in previous discussions.

Table 19:
Distribution of survey schools
(all public schools, except where noted)

		% low income				
Enrollment size	*Rural / urban*	**81-100%**	**61-80%**	**41-60%**	**21-40%**	**0-20%**
1-25	**Rural**	16		1		
26-50	**Rural**	4				
51-100	**Urban**	1				
	Rural	9	1			
101-250	**Urban**					2 *
	Rural	5				
250-500	**Rural**	3				
501 – 1000 (all FOD)	**Urban**	1	1			1
	Rural	1		1	1	
1001+ (all FOD)	**Urban**			1		1
	Rural			1		

* 1 public school, 1 private school

There are fifty public schools and a single private school in the sample; forty of the schools are in districts with the highest percentage of low incomes. There are 18 one-teacher schools in the sample, heavily concentrated in small rural schools in low-income areas. Obviously, one person teaches all subjects in these schools; an additional 22 of the 33 schools with more than one teacher in the sample also use teachers that teach all subjects.

The 11 multi-teacher schools in the sample with some teachers who are specialists in particular subjects include the 9 public schools with more than 500 students (all of which have FOD computer laboratories and FOD-certified computing teachers), the one private school in the sample (in the 101-250-student category, which also has a computer laboratory and a computing teacher), and a single 26-50-student rural school in the 81-

100% low-income group. The frequencies of teaching specialties in these schools are shown in Table 20.

Table 20:
Frequencies of specialized teaching

Area	# teachers
Computing	11
Religion	8
Music	7
Spanish	4
Science	4
Mathematics	4
Social studies	4
Plastic arts	3

There are three schools in the sample which have teaching specialists in at least 6 of the subjects in Table 20 – all of them public schools with more than 500 students, and all with FOD computer labs and certified computing teachers. Another five public schools have specialist teachers in at least music, religion and computing (FOD schools with computer labs), while the rest of the instances of specialized teaching (including one more FOD-certified teacher) are spread among the various schools in this group. From the point of view of our own interests, the fact that computing leads this list is encouraging, but the fact that mathematics and science do not occupy higher positions is less so.

Focusing more closely on the actual numbers of computers in the different schools, and the number of these that are available for student use, we found the following:

- Thirty-eight public schools in which students have had no access to computers – 30 with no computers of any sort, 7 schools with computers which are not for student use (6 with one computer and 1 with 3 computers), and one school which has purchased 11 computers which students have not yet been able to use.
- Three single-teacher public schools with minimal student access to computers – a FOD school with 2 computers, and 2 schools which do not yet have a FOD-certified computing teacher (one with a single computer for students, and the other with two computers for students).
- Ten "computer-rich" schools – all 9 large (more than 500 students) public schools, each with FOD laboratories containing between 15 and 21 computers for student use, and a single private school with an 11-computer laboratory for students – all of which have a teacher who specializes in computing.

When we asked representatives of the 30 schools who do not have any computers what prevented them from having computers, all cited lack of resources (and, in two cases, lack of electricity). Six of these schools mentioned the FOD in their replies – three stating that projects to obtain computers through the FOD were underway, and another three complaining that the FOD was not helping them to obtain computers.

It is interesting to note that all of the three schools that complained about lack of assistance have less than 100 students, while two of the three schools which did not complain have between 251 and 500 students – a pattern that exactly fits the FOD strategy of expanding its coverage in larger schools before smaller ones. The last of the schools that did not complain is a single-teacher school with less than 25 students; it will be interesting to see if it actually receives assistance from the FOD in the short term.

In the case of the eight schools which have computers, but none that students have been able to use, lack of resources was also cited as a cause for the absence of student computers. Three of these schools mentioned the FOD in their answers; one, in the 50-100 student category, complained about a lack of support from the FOD, another, in the 251-500 student category, stated that a project to obtain the computers was underway, and the third, with 51-100 students, has purchased 11 computers, but has not yet been able to purchase legal software licenses, without which the FOD will not provide the rest of the assistance necessary to create a fully functioning laboratory.

In the thirteen cases in which computers for student use were already present, the most interesting finding came from the two largest schools in the group (each with more than 1500 students). In the first case, it was claimed that a lack of computers (the existing lab has 21) has forced the school to limit computer training to grades 4-6; in the second case, it was stated that the laboratory capacity was insufficient to provide training for all students, and that as a result only students in grades 2, 3, 5, and 6 were currently being trained – following FOD policies that place higher priority on training older students within the first (grades 1-3) and second (grades 4-6) academic cycles.

These comments suggest a possible problem for the Costa Rican educational system in the future – having once provided computer labs in large schools, it may be forced at times to decide whether enlarging existing laboratories is more important than continuing to extend computer training into smaller schools; if it continues to place emphasis on larger schools, this could mean that help for the smallest schools will be even farther away than it seems to be at this moment.

The final point that we considered had to do with Internet access. Only five schools had such access – the single private school and four of the nine public schools in the “computer-rich” group that we introduced previously. We also found that another school in this “rich” group had recently removed its Internet connection, and that in one of the schools that currently had an Internet connection, only “advanced” (older) students were able to make use of it.

We believe that Internet use has become so vital to participation in modern societies at all ages (and far more generally useful than using standard office applications, or programming computers) that delaying training in its use until relatively late in primary school may not be advisable; in any case, all of these findings serve to emphasize the relative scarcity of student access to one of the most vital tools in knowledge-based societies.

On the basis of our previous discussion of computer and Internet access for students, we defined the following information-technology related categories for the schools in the sample:

1. No access to computers for students or staff – 30 schools
2. Access to computers for staff only – 8 schools
3. Minimum student access to computers – 3 schools
4. Computer laboratories for students, but no Internet access – 5 schools
5. Computer laboratories for students and Internet access – 5 schools

We use these categories to places the results of teacher and student interviews in context in several places in the rest of this document, but bear in mind that these categories do not perfectly reflect other dimensions of contrast that may be important. The specialized teachers, for instance, are highly concentrated in the schools in categories 4 and 5 above, but there are three schools with four or more specialized teachers whose schools are classified in category 1; these same three schools, in addition to two schools with computer laboratories, are in the 81-100% low-income category, and the rest of the schools with laboratories are in several different income categories.

B. Interviews with teachers

Interviews were conducted with 99 professors in the 51 schools in our sample. This includes the single teacher in each of the 18 single-teacher schools (including the single teacher with FOD training), 40 interviews in the 22 schools with multiple teachers who were not specialized in the teaching of a particular subject, and 41 interviews with teachers in the 11 schools that did have specialized teachers – 12 interviews with computing teachers, and 29 with other types of teachers.

We began by asking the teachers their opinions about the current state of primary education both at a national level and at the level of their own school. As Table 21(A) on the next page shows, the general response was positive, with a slightly more positive view of education in their own schools than of education at a national level. We then asked the teachers if they thought the quality of education was declining, remaining the same, or improving – once again, both at a national level and in their own school. As Table 21(B) shows, a slight note of pessimism is shown in their evaluation of education at a national level, while they continue to be more optimistic about their own schools than the country as a whole.

We analyzed these results controlling for factors such as local income levels and penetration of ICTs in the schools (using the categories defined in the last section); the only noticeable differences that we detected as a result of variations in these factors were:

- a tendency for teachers in the poorest areas to be more optimistic about the chances for improvement in their own schools in the future than those whose schools were in more prosperous areas
- a tendency for teachers in “computer-rich” schools to rate the current state of education in their own schools higher compared to the rest of the country than teachers in schools with less ICT penetration

Table 21:
Teacher opinions about the state of primary education
(N=99 in all cases)

(A) <u>current state of primary education</u>

	(1) in Costa Rica	(2) in your school
Very bad	1.01%	
Bad	1.01%	2.02%
Normal	31.31%	21.21%
Good	51.52%	52.53%
Very good	15.15%	24.24%

(B) <u>trends in primary education</u>

	(1) in Costa Rica	(2) in your school
Getting worse	17.17%	5.05%
Staying the same	43.43%	42.42%
Getting better	39.39%	52.53%

We performed a rudimentary check of the internal consistency of the teachers' answers to our questions by cross-tabulating the responses to the two questions about the country as a whole, and doing the same thing for the two questions about the teachers' own schools. This gave us the results in Table 22.

Table 22:
Teacher opinions: present vs. future

Trends in primary education

	In Costa Rica			In your school		
Current state of primary education	Getting worse	Staying the same	Getting better	Getting worse	Staying the same	Getting better
Very bad	1					
Bad	1				1	1
Normal	5	18	8	2	11	8
Good	9	20	22	3	22	27
Very good	1	5	9		8	16

We can see that there are two teachers who appear to be profoundly pessimistic about the state of Costa Rican education – not only is it "bad" or "very bad", but it is getting worse. At the opposite extreme, 31 teachers stated that Costa Rican education is "good" or "very good" and getting better, and 43 who said the same about education in their own schools. These answers give us the subjective impression that the extremes in the responses shown in Table 22 are likely to be the result of teachers who were being automatically positive (or negative) when answering our questions, rather than considering whether it is indeed likely that the “very good” will become even better, or the “very bad” even worse.

There is no doubt, however, that almost all teachers believe that there are things that need to be improved in Costa Rican primary education. When we asked the teachers to name the three subjects whose teaching most needed to be improved in the country as a whole and in their own schools, we received the replies summarized in Table 23. The figures in the table are numbers of times a particular subject was mentioned by teachers in the three opportunities each was given to name a subject, and do not add up to 99 teachers, as have the data in other tables.

Table 23:
Teacher opinions: subjects whose teaching needs to be improved

in Costa Rica		In your school	
# replies	**subject**	**# replies**	**Subject**
84	mathematics	85	mathematics
71	Spanish	73	Spanish
69	social studies	69	social studies
33	computing	28	Science
25	science	26	computing
8	religion	3	Music
1	music	3	plastic arts
0	plastic arts	3	Religion

The results for the country as a whole and the teachers’ own schools are very similar. They show that the teachers in our sample share the same worry about the quality of mathematics education that we have mentioned at several points previously. Given our own interests, it obviously attracts our attention that training in computer use and science are distinctly below Spanish and social studies on the list of subjects whose teaching should be improved (even when we control for local income levels, ICT penetration, and other factors).

Public schools clearly have a responsibility to assist in many aspects of the formation of citizens, and Spanish and social studies play a great role in producing literate and socially conscious Costa Ricans; however, the fact that the teachers themselves place mathematics at the top of their list of priorities clearly shows that they are aware of the importance of quantitative and logical skills in the modern world, and the distance between social studies (number three in both lists) and science or computing (numbers 4 and 5 in each list) in Table 23, given the shortage of well-trained technical and scientific workers mention in the introduction to this document, still gives us good reason to be concerned.

The teachers were asked in a final group of questions to select three actions from a group of 10 that they felt had the highest potential to improve primary education, in the country as a whole and in their own schools. Their responses are summarized in Table 24.

Table 24:
Teacher opinions: actions which could improve primary education

In Costa Rica		In your school	
# replies	**action**	**# replies**	**action**
78	train teachers more	75	train teachers more
50	improve physical infrastructure in existing schools	56	improve physical infrastructure in existing schools
41	increase parental involvement	54	increase parental involvement
35	use computers and the Internet more	31	evaluate the quality of teachers' work more strictly
29	evaluate the quality of teachers' work more strictly	28	use computers and the Internet more
22	increase the number of teachers	19	increase teacher salaries
20	increase teacher salaries	16	increase the number of teachers
9	evaluate exam results more strictly	5	evaluate exam results more strictly
6	increase the number of schools	2	increase the number of schools
0	increase the number of days in the school year	1	increase the number of days in the school year

As was the case in Table 23, the lists in the two sides of Table 24 very closely resemble each other, and indicate that teachers believe that the single most important action that can be taken to improve primary education is to improve teacher training. The fact that the teachers themselves believe that inadequate training is the most pressing problem to be solved (a finding which did not vary when we considered groups of teachers in different categories of local income levels, ICT penetration, and urbanization) is especially impressive since they, of all participants in the formal educational system, seem to in the best position to judge if this is true.

Interestingly, while the second item in the lists in Table 24, improving the physical infrastructure of the schools, was very frequently chosen by teachers in all income categories, it was chosen slightly more by teachers in higher-income areas (with between 40% and 0% of low incomes) than by those in lower-income areas – a finding that was contrary to our initial assumption that the item would be chosen more frequently by teachers in poorer areas, and one which indicates that dissatisfaction with infrastructure was very widespread.

The final point related to Table 24 that we wish to mention is the fact that the use of computers and the Internet was not seen as an especially effective solution to existing problems, even when we considered only the responses of computer teachers. Given the apparent problems with teacher training and physical infrastructure of the schools, this seems to be a rational response; technology is a facilitator, not a solution in itself, and can only have a substantial impact if it is introduced into schools in which teachers know how to make best use of it, and the physical environments in which it is used do not detract from the learning experience.

C. Interviews with students

When defining the types of students whose opinions and preferences we wanted to study, we decided to focus on students at the beginning and end of the primary educational process, and therefore limited our interviews to students in 2nd and 6th grades; we chose second-graders rather than first-graders because first-graders would have had almost no experience with the educational process when we talked to them.

In the best of cases, we were able to interview 5 students in each of the two grades in each school, which would imply a maximum student sample size of 510 boys and girls; the small size of many of the schools in our sample meant that at times there were not five students available to interview in each of those grades, which limited our final sample to 387 students – 96 boys and 97 girls in 2nd grade and 101 boys and 93 girls in 6th grade.

1. Popularity and perceived usefulness of courses

We first asked the students how much they liked each of the four principal subjects in the MEP curriculum, and, in those cases in which they received English and/or computing courses, how much they liked those subjects. Table 25 summarizes their replies; we present only the percentages of students that liked each subject "very much" (as opposed to "not much", or "some") as a summary indicator of student preferences. As can be seen, the number of student opinions about English and computing are smaller than those about other subjects, reflecting the fact that far fewer students receive education in these areas than receive the basic MEP courses.

Table 25:
Percentages of students that very much like given courses
(N = number of students replying)

	2nd grade		6th grade	
	boys	**girls**	**boys**	**girls**
	N=96	*N=97*	*N=101*	*N=93*
Spanish	69.79%	67.01%	32.67%	38.71%
social studies	47.92%	49.48%	41.58%	34.41%
mathematics	82.29%	76.29%	56.44%	49.46%
science	61.46%	51.55%	67.33%	55.91%
	N=48	*N=53*	*N=57*	*N=51*
English	64.58%	69.81%	59.65%	62.75%
	N=26	*N=22*	*N=28*	*N=30*
computing	92.31%	90.91%	71.43%	80.00%

The results in Table 25 can be summarized as follows:

- The subject that students like the most is computing, for both sexes in both grades. The second most popular subject in second grade for both sexes is mathematics, while in sixth grade it is science (for boys) and English (for girls). The least popular subject in second grade for both sexes is social studies, while in sixth grade it is Spanish for both sexes.
- With the exception of science, all subjects decline in popularity for both sexes between 2nd and 6th grade; the largest declines are in Spanish (both sexes), mathematics (both sexes), computing (boys), and social studies (girls).
- In subjects that are of specific interest to this study, boys are more enthusiastic about mathematics and science in both grades than girls, whereas girls are more enthusiastic about English in both grades, and about computing in 6th grade.

We see that students are especially enthusiastic about exactly those subjects that we are emphasizing as important in the creation of skilled human resources for new economies. It is excellent news that no artificial efforts need to be made to stimulate student enthusiasm in these critical areas, but this makes it even more critical to provide the appropriate teachers and environment to support this enthusiasm. There is no doubt that this is a substantial challenge for the educational system; the enormous number of small rural schools in the county which do not now have, and will not soon have, computers and computer training immediately comes to mind.

The decline in the popularity of mathematics between 2nd and 6th grades, and the relative unpopularity of social studies and Spanish, fit well with the perceptions of teachers about those areas in which teaching must be improved; in the opinion of those teachers, the most important step to be taken is to improve teacher training, but the costs and complexity of doing so are formidable. Teachers should also be aware of the need to stimulate enthusiasm about mathematics and science in primary school girls, who should have the opportunity to participate in scientific and technical areas of the economy and society in the future on an equal basis with their male classmates.

We also asked students how useful they felt that the teaching that they were receiving in different subjects would be in their adult lives. Their replies are summarized in Table 26 on the next page, using the same format that we used in Table 25 (only students who actually receive English and computing courses have their opinions about those subjects included in the table). Boys in both grades believe that computing will be most useful, while 2nd grade girls think that mathematics will be most important and 6th grade girls give the highest rating to English. The second-highest ratings mention the same three subjects – 2nd-grade boys choosing mathematics, 6th grade boys and 2nd grade girls choosing English, and 6th grade girls naming computing.

The image that emerges from these results is than of students who place a high value on being quantitatively and technically skilled bilingual adults – exactly what we ourselves believe to be necessary for successful participation in global information-based economies. However, we also note that they believe that their education in science will be one of the least useful things they are currently receiving; this indicates that steps must be taken to convince students that being a scientist is a viable and attractive alternative for them in their future lives.

Table 26:
Percentages of students that believe given courses will be very useful in the future
(N = number of students replying)

	2nd grade		6th grade	
	boys	girls	boys	girls
	N=96	*N=97*	*N=101*	*N=93*
Spanish	79.17%	78.35%	66.34%	66.67%
social studies	67.71%	63.92%	50.50%	51.61%
mathematics	85.42%	81.44%	75.25%	70.97%
science	65.63%	68.04%	67.33%	59.14%
	N=48	*N=53*	*N=57*	*N=51*
English	81.25%	81.13%	77.19%	88.24%
	N=26	*N=22*	*N=28*	*N=30*
computing	100.00%	68.18%	78.57%	86.67%

The differences between boys and girls in the perceived future advantages of education in different subjects are largest with regards to science (6th grade boys valuing such education more highly than 6th grade girls), English (6th grade girls valuing it more highly than 6th grade boys), and computing, which was highly valued by all boys and only two-thirds of girls in 2nd grade, and 79% of boys and 87% of girls in 6th grade. The very large positive change between 2nd and 6th grades in the evaluation of the value of computing skills by girls is an extremely positive sign, indicating that older girls believe that they will indeed be making use of information technology in their adult lives.

2. Computer and Internet use

We collected basic data from the 106 students in our sample who use computers in their schools – 26 boys and 23 girls in the 2nd grade and 27 boys and 30 girls in the 6th grade. Ninety of these students are trained in FOD computer laboratories, 10 in a private school computer laboratory, and 6 in two small public schools with a total of three computers. As a result, the training that the great majority of them receive is highly standardized and similar from one school to the next, regardless of variations in local income levels and other factors.

Our first finding was one of the most interesting -- only 6 of these students have access to a computer more than once a week, and these students are in two of the smallest schools in our sample. That is, even when students in schools with “computers for student use” actually *have* access to those computers (and some do not), it is infrequent.

In general, the students are highly enthusiastic about the training they receive – 101 out of 106 (95%) of the students indicated that they "liked" computer training, and 97 out of 106 (92%) indicated that the courses were "easy". This re-emphasizes the impression that little effort needs to made to stimulate enthusiasm for learning in areas that are critical to the quality of life of these children when they become adults in a global economy – what needs to be done is to provide the resources that they need to turn that initial enthusiasm into learning.

Next, we asked all of the students currently receiving computer training to tell us what they were doing with the computers. We offered them four alternatives:

- Learning basic mechanical skills (keyboard and mouse use) – the entry point to all computer and Internet use
- Creating and modifying documents – the basic IT skill of an office worker
- Programming – the traditional basic skill of a computer technical worker
- Playing games – the most natural activity for a child with computer access

The fact that programming could be included in the list, even though we were interviewing primary school children, is due to the FOD's promotion of visually-oriented programming in the LOGO language as a tool to develop critical reasoning abilities. When we included game playing in our options, it was with the expectation that we would find that a very attractive computer activity for children was absent in formal computer training; however, games were cited as an activity with some frequency (in some cases it seems that these responses actually referred to the programming exercises in the FOD curriculum[12]). In any case, the responses to our questions are summarized in Table 27.

Table 27:
Computer use in school
(N = number of students replying)

	2nd grade *N=49*	**6th grade** *N=57*
using a keyboard and mouse	79.59%	77.19%
creating documents	24.49%	57.89%
programming	26.53%	47.37%
using games	46.94%	31.58%

Even with only occasional access to computers, students who participate in these training courses will probably have reasonable mechanical computer-use skills in later years, since these skills are naturally emphasized from their earliest years with computers. The office-worker skill of creating and editing files seems to be more highly emphasized in later years that in earlier ones, as does programming.

Even though the courses that FOD students receive are intended to teach reasoning skills as much as they are meant to teach programming itself, we can still conclude that

[12] The LOGO approach to programming training for children is presented in some ways as a game (see <el.media.mit.edu/logo-foundation/logo/turtle.html>).

students who have passed through this training will have some of the skills necessary to actually program computers in later years. Since the advent of graphical user interfaces for computers in the mid-1990s, the importance of programming skills in managing one's own computer has decreased substantially, but there is still a great demand for professional programmers in many areas of information societies, and the technical aspects of the training provided in the FOD curriculum are accordingly valuable to the students and to Costa Rican society.

The originators of the LOGO approach would be the first to agree that computer game playing has the capacity to improve basic computer skills – mechanical and otherwise – and there can be no doubt of the attractiveness of computer game playing for youngsters. Table 28 presents the responses of the 69 students in our sample who had computers in their homes (49 of whom also used computers in their schools) when they were asked what they did with those computers; as usual in presenting results of this type, the table records the number of student *responses*, not the number of *students* replying.

Table 28:
Computer use in the home

Playing games	56
Doing homework	40
Learning to use a computer	31
Using Internet	7

Although the frequency of computer use for homework indicates that children are not completely free to do what they want with computers when they use them in their home, and the presence of the Internet option at the bottom of the list is due more to the absence of Internet connections than the unpopularity of the Internet, the presence of game playing at the top of the list reflects the simple attractiveness of games to children, and clearly implies that either formal education disguised to some degree as a game (as in the case of LOGO), or simply playing games on computers, are both very promising ways to increase the familiarity of primary school students with computers.

We also asked the children with computers in their homes how often they used those computers, and whether anyone helped them to use them. Not only did 59 (86%) of the students use computers "several times a week", but 25 (37% of all cases) of them did so without any help from other persons; when help was provided, it came most frequently (in 48% of all cases) from parents.

Table 29:
Frequency of assisted computer use in the home
(N=69 students)

	Who helps you?	How often do you use a computer at home? Once a week	Several times a week
2nd grade	No one	2	10
	Parents	2	12
	Siblings		3
	Other family members		1
	friends	1	
6th grade	No one	1	12
	Parents	1	11
	Siblings	2	8
	Other family members	1	2

There were 10 6th grade students in the sample that reported using the Internet in school once a week, primarily for homework assignments helped exclusively by teachers. Table 30 contains their responses to our questions about what they used the Internet for in school.

Table 30:
Internet use in school
(10 students responding)

Doing classwork/homework	8
Looking for things that I like	4
Learning to use the Internet	2
E-mail / chat	2

There were 21 students who reported using the Internet from their home, only three of whom also used the Internet in school. Ten of these home Internet users used it once a week, while the other 11 students used it multiple times a week. As Table 31 shows, primary school students actually use the Internet for personal enjoyment (including Web searches and e-mail/chat) far more than they do for completing homework assignments; once again we see signs of a genuine enthusiasm for using a technological tool whose facile use is a critical part of successful participation in knowledge-based societies.

Table 31:
Internet use in the home
(21 students responding)

Looking for things that I like	17
Doing classwork/homework	13
E-mail / chat	10
Learning to use the Internet	9

More than half of the students with Internet access in their home reported using the Internet without any assistance; once again, when assistance was provided, it came most frequently from parents.

Table 32:
Frequency of assisted Internet use in the home
(N=21 students)

	Who helps you?	How often do you use the Internet at home? Once a week	Several times a week
2nd grade	No one		1
	Parents	3	
	friends		1
6th grade	No one	4	6
	Parents	2	1
	Siblings	1	1
	Other family members	1	

The final series of questions for students had to do with the degree to which parents helped them with computing. We had at least two reasons to suspect that parental assistance in this area might be substantially less than in other subjects – parents themselves might not be familiar with computers, and there might not be a computer in the student's home, without which parental assistance would necessarily be minimal.

Table 33:
Degree of parental assistance
with computing and other courses
(N=number of students responding)

	Computing	Computing *(homes with computers)*	Spanish	Social Studies	Math	Science
	N=106	*N=49*	*N=387*	*N=387*	*N=387*	*N=387*
Never	52.34%	32.65%	10.85%	10.85%	12.66%	11.89%
Not very often	18.69%	24.49%	10.34%	12.40%	9.82%	9.30%
Sometimes	16.82%	22.45%	25.84%	23.51%	23.00%	25.32%
Often	12.15%	20.41%	52.97%	53.23%	54.52%	53.49%

Table 33 shows that parental assistance with computing was indeed very low compared to other subjects, even if there was a computer in the home. Given the very high level of parental aid in other, traditional, subjects, it seems unlikely that the lack of assistance is due to a lack of desire to help children; the more likely possibility is that parents do not know enough about computing to help as much as they can in other subjects. If this interpretation is correct, then the quality and quantity of computing teachers in schools becomes an especially critical factor in determining if Costa Rican primary students are well –prepared for the future.

VIII. A brief survey of Costa Rican scientists

In investigating the production of Costa Rican citizens with capabilities that are critical for participation in knowledge-based societies, it is interesting to consider the primary school experiences of Costa Ricans who have in fact become highly trained in the areas of science, mathematics, and information technology.

We were granted access to the membership list of the National Council for Scientific and Technological Investigation (CONICIT), and a list of Costa Rican scientists who had been awarded scholarships to complete studies for post-graduate degrees outside the country. We communicated with these scientists by e-mail, and requested that they fill out an Internet-based questionnaire that contained some of the same questions that we asked the current primary school students in our survey. Although only 4 of the 114 scientists that have responded at this time were young enough to have been exposed to computers in primary school, the information that we obtained about the education and experiences of the scientists in other areas was extremely useful.

The information in Table 34 places the primary schools of these scientists in the context of local income, rurality, and sector (only 103 of the responding scientists included enough information to be included in the table).

Table 34:
Costa Rican scientists -- distribution of primary schools

	Public		Private	
% of low incomes	**Urban**	**Rural**	**Urban**	**Rural**
81-100%	3	4	1	
61-80%	3	3	1	
41-60%	7	3	2	1
21-40%	4	3	5	
0-20%	37	8	18	

Fifty-three of the 103 schools (53%) are in the wealthiest urban areas, while only four of them are in the lowest-income rural areas. Only 10 of these schools (8 in rural areas) had 100 or less students, while 52 (43 in urban areas) had between 101 and 500 students, and 41 (36 in urban areas) had more than 500 students. In short, the Costa Rican scientists in our sample come in highly disproportionate numbers from larger urban schools in wealthier districts.

We asked the scientists which subjects were their favorites in primary school, and which subjects were most difficult for them. Given the fact that the members of the group responding are professional scientists, it comes as no surprise that the favorite subject most often mentioned was science, followed in descending order by mathematics, social studies, and English.

The course most often cited as difficult was Spanish, which fits well with our findings from current primary students, who rated Spanish as one of the subjects they like the least (see Table 25), as was social studies, which is also frequently mentioned as a “difficult” course by the scientists. Finding that mathematics was the second-most mentioned “difficult” course for those students that were interested most in science in primary school was a surprise; it seems to have sometimes been a challenge that was overcome on the way to becoming a scientist, rather than something that was especially enjoyable or easy in itself in the earliest years of education.

Table 35:
Costa Rican scientists – favorite and most difficult primary school subjects

	Most difficult subjects						
Preferred subjects	**Computing**	**Science**	**English**	**Social studies**	**Mathematics**	**Spanish**	**(total)**
Science				18	21	32	**71**
Mathematics	1	2	3	8	2	15	**31**
Social studies		1			3	6	**10**
English						2	**2**
(Total)	**1**	**3**	**3**	**26**	**26**	**55**	**114**

Perhaps the most important conclusion that can be drawn from Table 35 is that the preferences of future scientists are established early. Given our findings in other sections of this investigation that younger primary students are especially susceptible to the effects of variations in factors such as local income levels, student-teacher ratios, and teacher experience, this is an extremely strong argument for improving the quality of teaching for younger students in the areas of mathematics and science, as well as for improving their access to computers and the Internet.

While there is currently general agreement on the need to improve teaching in mathematics, we have seen that teachers are not worried to the same degree about the quality of teaching in science at any age, and that the policy governing computer and Internet access in public schools emphasizes older students rather than younger ones. It can be asked whether it makes a significant difference if students in the first educational cycle (grades 1-3) are not exposed to high-quality teaching and computer use if they do receive such training in the second academic cycle (grades 4-6; we have seen, for instance that computer training and Internet access are sometimes only available in the Second Cycle); our only reasonable response is that the evidence seems to suggest in a very general way that the earlier high-quality resources are made available to students, the better it will be for them in later years.

We were extremely interested in the evaluations of the usefulness of different academic subjects in later life by the scientists in our sample. The results must obviously be interpreted with care, since the responses reflect the fact that those who are responding are, indeed, scientists – it is actually more unusual to see that slightly less than 9% of scientists did not regard science training as having been useful in their later lives than it is that more than 91% of them did see such training as useful. On the other hand, the scientists are singularly relevant sources of information, since they represent in extreme form exactly the type of quantitatively skilled critical thinkers that we believe to be an especially vital resource for the future of Costa Rica.

Table 36:
Costa Rican scientists – most useful subjects in later life

Science (N=113)	91.15%
English (N=60)	88.41%
Mathematics (N=113)	84.21%
Spanish (N=113)	77.19%
Social Studies (N=113)	46.49%

It is informative to compare the results in Table 36 with the perceptions of current primary school students about the future usefulness of learning different subjects (see Table 26). Leaving aside computing, which the scientists were not asked to evaluate, we begin by noting the very large difference between the usefulness of science training to current scientists (by definition, very high) and the low rating of science training by current primary school students.

The next two subjects in the list in Table 36 are exactly the two subjects that grade school students mentioned (after computing) as most likely to be useful – being quantitatively skilled and bilingual are in fact as important for scientists as students imagine that they will be in their own future lives. Likewise, Spanish and social studies receive lower rankings by both current students and the current scientists, although Spanish seems to be more important than the students imagine.

In general, we can conclude that the primary school students of today are estimating the future value of most areas of their education in a way that does reflect their utility in a knowledge-intensive workforce, but that they do not seem to be anticipating that they will be scientists themselves, or that science training may be extremely important in their lives even if they do not actually become scientists. As we stated previously, it would be extremely worthwhile to convince these students that scientific training will be useful to them, and that working as a scientist is indeed an option; we can imagine no group of people better qualified to help them believe this than the Costa Rican scientists whose experiences are summarized in Table 36.

IX. Conclusions and recommendations

We began the analytical portion of this document by studying the distribution of schools and students in Costa Rica in terms of local income levels, rurality, school size, and other factors. Our findings – that there is a highly bimodal distribution of schools between relatively large urban schools in wealthier areas of the country and smaller rural schools in relatively poorer areas of the country – will come as a surprise to no one who is familiar with Costa Rican education, but nonetheless help us to understand in quantitative terms the dimensions of the problem that the formal educational system faces in providing high-quality education to all of the country's children.

We next attempted to give some quantitative dimensions to the effects on the quality of children's education of several factors which are often cited in the study of educational systems – poverty, rurality, private schools as an alternative to public schools, teacher qualifications, numbers of teachers, and student-teacher ratios. Although the data we had to study these issues was less than perfect for our purposes, our results clearly show the negative impact of lower local income levels on education, and the lesser but consistently negative impacts of rurality, high student-teacher ratios, and lower levels of teacher preparation.

During this stage of analysis, we also found clear evidence of a need to improve teaching in mathematics, a tendency to pass very high numbers of students in 6th grade and the 6th-grade MEP special exams that suggests a reluctance to keep students in primary schools when they are expected to pass to secondary education, and an extremely interesting and consistent tendency for students in the First Academic Cycle (grades 1-3) to be more susceptible to variations in different factors than students in the Second Academic Cycle (grades 4-6).

These findings obviously lead to several very general recommendations, including focusing on improving the quality of mathematics training through improving teacher skills in this area (perhaps providing more teachers who are specialists in mathematics teaching, rather than educational generalists), investigating in more detail the causes of unusually high rates of students passing regular and special 6th-grade examinations, and paying particular attention to the quality of teaching of the very youngest students, whose performance is most notably affected by lack of attention and resources.

Studying information related to the use of computers and the Internet, we found that access to these vital resources is heavily concentrated in larger schools, which tend to be found far more often in wealthier urban areas than in poorer rural ones; in fact, a very large number of small rural schools have to access to either computers or the Internet, and very little chance of gaining such access in the near future. We do not fault the strategy that has led to this situation, and applaud efforts to extend access as resources permit; our recommendation in this area is rather that priority be given to funding the extension of this access. Being able to use these tools effectively is absolutely fundamental to participation in modern societies at a level that will allow Costa Ricans to continue enjoying the high standard of living and levels of social support that they are accustomed to.

The first section of the analysis of data from our own surveys clearly showed the difficulties that even large schools with computer laboratories and Internet access are experiencing in trying to provide training for all of their students – access is being limited to older “advanced” students in some cases, which both our own experience and the evidence in this document of special sensitivity of younger students to lack of proper resources suggest can have stronger negative effects than are perhaps being anticipated by educational authorities. Once again, we see cause to stress the funding of computer and Internet access programs.

Our survey showed that teachers specialized in computer training were the most frequent type of educational specialists in the sample. This, together with the high priority placed on improving teaching in mathematics, is a positive sign for the future from the perspective of creating information-society citizens. Other lines of evidence were not so positive – there were few teachers currently specialized in mathematics or science, and the improvement of teaching in computing and science were low priorities in the opinions of the teachers interviewed. The improvement of teaching in computing is closely associated to recommendations that we have already made to support increased funding for computing programs, but we also strongly recommend that educational authorities emphasize the improvement of teacher skills in the area of science (perhaps through increasing the number of specialized science teachers).

When we turned to the results of our interviews with students, we discovered that they seem to be naturally enthusiastic about several of the subjects that we regard as being most important for the future – they almost universally like computing courses when they are available (although they only have access to computers one day a week), for instance, and are also favorably disposed towards mathematics. When computers and Internet connectivity are available in their homes, students tend to use them frequently for their own enjoyment; we have to do nothing more than try to imagine these same students using their own time to study mathematics, science, or any other academic subject to realize the enormous opportunity that is presenting itself to take advantage of this enthusiasm by providing basic computer access and qualified teachers in primary schools. When we realize how few homes have computers, and the especially low level of parental assistance in learning how to use computers even when there *are* computers in the home, the importance of having computers and skilled computing professors is only emphasized.

The relatively low level of student enthusiasm for science, and the sharp drop in enthusiasm for mathematics between second and sixth grades, are cause for concern. Mathematics teaching is already a general concern in the Costa Rican educational system, but we encounter here yet another reason to recommend that special emphasis likewise be placed on improving the teaching of science in primary schools.

The need for strengthening education in science is also documented by the students’ evaluation of the future usefulness of the courses that they are receiving. While they are united in believing that computing, mathematics and English will be highly useful, they do not share this same belief about science. We seem to detect an image in the minds of students of being bilingual quantitatively- and technically-skilled adults who will neither be scientists, nor need the conceptual tools that scientific training will provide them; in fact, the abilities to think critically, and to solve real-world problems systematically, are strengthened by high-quality training in science as they are in no other subject, including computer programming and mathematics. Students should be made aware of this, and provided with the level of teaching that will strengthen these abilities.

Although we do not believe that the best possible outcome of formal education is necessarily the creation of professional scientists, we certainly believe that it is a good thing for any society or economy to include substantial numbers of scientists if innovation and the successful application of knowledge to the improvement of the quality of life are regarded as desirable.

From this point of view, the fact that the successful Costa Rican scientists of today were already strongly interested in science when they were in primary school strongly suggests that scientific education should be emphasized in the country's schools from the earliest years of primary education. The fact that current primary school students already believe that mathematics and English will be useful to them in the future, and current scientists confirm that education in these areas has in fact been highly useful in their careers, leaves only the task of convincing the students of today of the basic importance of science itself in order to produce the scientists of tomorrow.

The process of achieving the effective participation of Costa Ricans in information-rich global societies and economies is a complex one, and we cannot expect to rapidly or easily achieve our goals. We believe that the findings of our investigation have given us valuable indications of problems that must be overcome, and strategies that must be emphasized, in order to do so; we look forward to participating in the evolution of the educational system that must be developed in the coming years in order to maintain and extend the prosperity of Costa Rica and its citizens.

Appendix: Population and school data

Categorized by ranges of
percentages of populations with low incomes (columns)
and percentages of populations living in rural areas (rows)

*Based on district-level data unless otherwise indicated **

(A) Distribution of the national population in terms of local income levels and rurality -- 2000

	% low incomes					
rurality	**81-100%**	**61-80%**	**41-60%**	**21-40%**	**0-20%**	**TOTAL**
81-100%	794,818	95,038	50,683	28,069	27,448	**996,056**
61-80%	210,654	76,789	11,939	--	--	**299,382**
41-60%	138,973	111,235	65,362	21,539	24,266	**361,375**
21-40%	89,653	24,149	148,992	151,322	14,680	**428,796**
0-20%	69,520	253,504	366,137	292,502	742,907	**1,724,570**
TOTAL	**1,303,618**	**560,715**	**643,113**	**493,432**	**809,301**	**3,810,179**

(B) Area in km^2 for each of the categories in Table A

	% low incomes					
rurality	**81-100%**	**61-80%**	**41-60%**	**21-40%**	**0-20%**	**TOTAL**
81-100%	33,992	467	295	100	52	**34,905**
61-80%	7,365	536	64	--	--	**7,965**
41-60%	3,093	1,374	358	27	55	**4,907**
21-40%	1,159	371	487	237	13	**2,266**
0-20%	19	893	541	98	256	**1,807**
TOTAL	**45,628**	**3,640**	**1,745**	**461**	**376**	**51,850**

(C) Inhabitants / km^2 *(from tables A and B)*

	% low incomes					
rurality	**81-100%**	**61-80%**	**41-60%**	**21-40%**	**0-20%**	**TOTAL**
81-100%)	23.38	203.70	171.98	281.45	529.17	**28.54**
61-80%	28.60	143.34	185.45	--	--	**37.59**
41-60%	44.93	80.98	182.64	790.71	442.08	**73.65**
21-40%	77.38	65.05	306.16	639.73	1,158.64	**189.26**
0-20%	3,672.48	283.83	676.59	2,998.79	2,899.94	**954.40**
TOTAL	**28.57**	**154.03**	**368.60**	**1,070.24**	**2,154.63**	**73.48**

Appendix 1 (cont) :

(D) Number of students (2001)

% low incomes

rurality	81-100%	61-80%	41-60%	21-40%	0-20%	TOTAL
81-100%	131,595	12,851	6,461	3,165	2,989	**157,061**
61-80%	33,984	11,092	2,012	--	--	**47,088**
41-60%	22,466	15,419	9,520	2,338	2,484	**52,227**
21-40%	12,584	3,515	20,172	16,385	2,171	**54,827**
0-20%	8,758	34,947	45,517	33,531	99,884	**222,637**
TOTAL	**209,387**	**77,824**	**83,682**	**55,419**	**107,528**	**533,840**

(E) Number of primary schools (2001)

% low incomes

rurality	81-100%	61-80%	41-60%	21-40%	0-20%	TOTAL
81-100%	2,019	77	41	17	14	**2,168**
61-80%	425	83	11	--	--	**519**
41-60%	213	107	44	8	10	**382**
21-40%	76	34	110	51	6	**277**
0-20%	11	103	106	66	260	**546**
TOTAL	**2,744**	**404**	**312**	**142**	**290**	**3,892**

(F) Primary school students in “rural” and “urban” schools by income levels (2001)

% low incomes

	81-100%	61-80%	41-60%	21-40%	0-20%	TOTAL
RURAL	195,039	51,306	45,839	27,827	16,348	**336,359**
URBAN	14,248	26,518	37,843	27,592	90,944	**197,145**
TOTAL	**209,287**	**77,824**	**83,682**	**55,419**	**107,292**	**533,504**

(G) Number of primary schools in “rural” and “urban” areas (2001)

% low incomes

	81-100%	61-80%	41-60%	21-40%	0-20%	TOTAL
RURAL	2,701	331	221	89	66	**3,408**
URBAN	34	71	91	51	219	**466**
TOTAL	**2,735**	**402**	**312**	**140**	**285**	**3,874**

* *Data sources:*

Data on % of district populations with low incomes (used to create Tables A-G) and in rural areas (used to create Tables A-E) for each district in the country from the year 2000 national Census (www.inec.go.cr).

Data on the areas of each district (used to create table B) from www.mideplan.go.cr/cedop/ids-informe2001.pdf.

Data on the number of primary schools in each district (used to create Table G), and the number of students in each of these schools (used to create Table F), from the Ministerio de Educación Pública (MEP).

Data on whether schools are "rural" or "urban" (used to create Tables F-G) from the Ministerio de Educación Pública (MEP).