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ANIBAL PINTO
Director of the Review

EUGENIO LAHERA
Technical Secretary

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How much *can we spend* on education?

Guillermo Labarca

Consultant, Division of Production, Productivity and Management, ECLAC.

The technology employed by Latin America's educational systems was developed by the countries which are now industrialized. This technology is labour-intensive, with expenditures being concentrated in the salaries of teaching staff and administrative personnel, and its effective utilization –as it is applied in the industrialized countries– entails a high level of expenditure per student. In line with recommendations made by international agencies, many Governments in the region have voiced their intention to raise the amount they spend on education to between 6% and 8% of the gross domestic product. The Latin American countries would have to spend much more than this, however, in order to create an efficient system affording universal coverage. Public education does not have the means of obtaining sufficient funding; only private schools receiving financial support from their students' families are in a position to use these technologies properly. In order to solve the region's educational problems, a policy is needed that will encourage the development of more efficient –and, in general, more capital-intensive– educational technologies based on the successful experiments that have been undertaken in the region.

I

Introduction

Rarely in the history of education in Latin America has there been such a meeting of minds on the part of the various social actors as to what formal education currently is and what it ideally ought to be. Governments, educators, scholars, businesspeople, workers, churches, cultural groups and others have similar objectives for education and talk about these objectives in very similar terms. Most studies on the subject indicate that educational coverage is being expanded at all levels, but the quality of education is declining. It has also been found that formal education does not fully meet the present and future demands of the production apparatus and makes no significant contribution in terms of greater social equity. The studies also agree on what the most important challenges for education are.

Some of these challenges are mentioned over and over again: upgrading the quality of education while making the necessary modifications to adapt curricula and teaching methods to the advances that have taken place in science, technology and pedagogy; establishing a more free-flowing relationship with the labour market and with higher education, to include the incorporation of the major technical changes occurring now and likely to occur in the near future; creating educational conditions that will help to change the region's production patterns and increase the level of social equity; emphasizing a type of education that focuses on development of each individual's skills rather than forms of instruction aimed primarily at the acquisition of book knowledge; inculcating ethical principles and values that will help the individual to operate successfully in the various spheres of society; and providing all students with access to the codes of modern-day society, which entails, among other things, improving the quality of instruction in the sciences and technology (ECLAC, 1990).

There is also some agreement as to what the best strategies are for meeting these challenges, or at least what the countries need in order to progress towards these objectives. Those that appear to be attracting the most attention are: decentralization of the educational system and greater autonomy for the schools in regard to their curricula and administration; a form of regulation that will allow the various units of the educational system to coordinate with one another and with their economic, social and political environments; policies based on a consensus among all the sectors involved; and universal access to mid-level or secondary education (on the assumption that universal coverage has already been achieved at the elementary level) (ECLAC, 1990).

Obviously, however, mere agreement on principles and on the steps to be taken is not sufficient to ensure that policies will be effective. The formulation and implementation of strategies are affected by rigidities which generally stem from conflicts with macroeconomic policies and efforts to balance the budget, education systems' infrastructural shortcomings, a shortage of skilled human resources (especially in vocational and technical education), demands –whether well- or ill-founded– made by teachers unions, an ignorance of the most appropriate educational technologies, the lukewarm support forthcoming from social institutions (including business firms) when their assistance is required for the implementation of certain types of plans, and the absence of an appropriate cultural environment.

But the greatest obstacle of all –and this constitutes the central argument to be made in this article– is the impossibility of applying the educational models implicitly or explicitly called for by the proposals being made for improving the quality of education in Latin America, because of the financial and cultural constraints imposed by the regional environment.

In order to back up this assertion, we will first outline the various educational models and their associated technologies. Next, we will look at the distribution of expenditure on education in industrialized countries and in Latin America and the way in which the current educational model is applied in the region. A number of technological options for education will then be proposed, followed by an examination of their effects in terms of educational policy.

□ The observations and comments made by Joseph Ramos and Jorge Katz regarding a preliminary version of this article enabled the author to define many concepts more precisely, refine the arguments presented, and organize the information more coherently. Any instances of inaccuracy or confusion that may remain are the sole responsibility of the author.

II

The models serving as a frame of reference

The region's educational models are based on the French lycée, the German "Gymnasium" and the "comprehensive" schools of the United States, Sweden or England, which have set, to a greater or lesser degree, the pattern for the region's educational systems at least since the start of this century. Elementary schools have also felt this influence, and in many instances are a watered-down version of the secondary school. These models have played a considerable part in determining the schools' objectives, the content of instruction and the pedagogic technologies used in general education. The differentiation between general education in the sciences and humanities and technical education also stems from the application of these organizational and pedagogical models in Latin America. It is true that these models have been adapted to local circumstances, but the adaptations have not been so radical as to change the essential aspects of the models (Programme for Better-Quality Education with Greater Social Equity (MECE 1.2), 1993).

The educational reforms being proposed and, in part, now being implemented in Latin America are measures aimed at adapting these models to the economic and social needs of today. This process has already been carried out or is currently under way in many industrialized countries and, in almost every case, conforms to the organizational principles and pedagogic technologies of the original model. Chile, Colombia, Jamaica, Mexico and other countries have undertaken educational reforms of this type.

From the standpoint of educational technology, which is the main focus of this article, the educational systems that are serving as a model for the region use books as the principal instructional vehicle and draw upon positive science for their curricular content and method. The technological foundations for these systems were laid early on in the nineteenth century in Europe and attributed specific functions to the teachers and teaching materials. The North American educational model –the comprehensive school, which was later adopted, with some major or minor modifications, by the United Kingdom, Japan and the Scandinavian countries– has altered some aspects of the European educational systems' structure at the secondary-school level, but has made no substantive modifications in their educational technology (Johnson and Packer, 1987).

Books assume the existence of a certain cultural context and of a series of institutions which, directly or indirectly, support the efforts of the school. These include school, community or neighbourhood libraries which give students broad access to books; the art, technology or science museums found in all cities in the developed world, which supplement and illustrate concepts and information learned in the classroom; newspapers and magazines or television programmes whose references and analyses raise issues and furnish information which can then be integrated into schoolwork; and in some cases, especially in Germany and more hesitantly in other countries, a relationship with the production sector which facilitates the task of vocational and technical schools (Johnson and Lundvall, 1988).

In these various educational modalities, books are the repository of knowledge and each teacher is an initiator and commentator on particular scientific subjects. Teachers are therefore the other essential component in these school systems' "educational technology";[1] they are distinguished more by their specialization in a given field of knowledge than by their pedagogical merits. Some of the roles they play in disseminating knowledge include assisting students to define the boundaries of their field of study and organize the relevant information, helping students get started on information searches and guiding them during that process, and informing them about scientific advances. With this educational technology, knowledge is basically to be found in books, but it is the teacher –i.e., a highly specialized and qualified human resource– who activates it. Teachers need to have a strong grasp of their fields and must be equipped to answer students' questions and clear up their doubts; they also must organize their work in such a way as to generate incentives that will structure their students' activities, as well as monitoring and evaluating their progress.

[1] The term "technology" is used here to denote a combination of material and human resources. In education, the paramount human resource, for any type of economic calculation, is the teacher.

The overall work of a teacher includes actual teaching in the classroom, reading-up for and preparation of the classes, providing individual attention to students, supervising and correcting examinations and tests, and performing duties connected with the administration and running of the school. The amount of time devoted to each of these tasks varies from one country's educational system to another, but on average teachers spend between 35% and 50% of their time in the classroom; between 20% and 33% on lesson preparation, reading to keep abreast of advances in pedagogy and scientific disciplines, correcting tests and attending to students' needs; and the rest of their time on administrative duties, in-service training and other tasks.

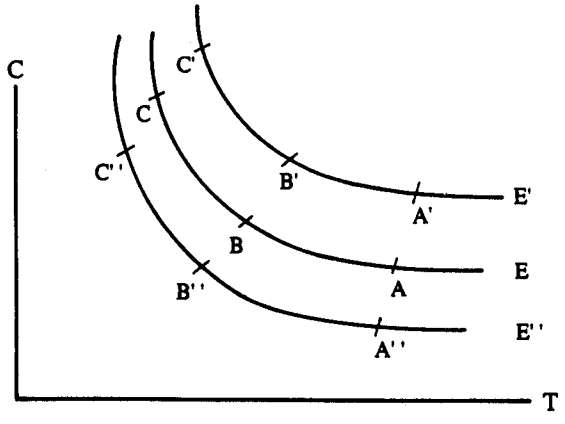
Originally (in the nineteenth century in Europe and the twentieth century in the United States and Japan), this way of organizing education was intended to provide society with leaders and senior public officials. After the Second World War, the educational system's coverage was broadened in these countries as they became more democratic and reorganized their production structures. This raised the amount of money spent on education considerably. On average, between 1950 and 1960, the percentage of gross domestic product (GDP) which the countries of the Organization for Economic Cooperation and Development (OECD) spent on education climbed from 3% to 5% and has hovered around these levels since that time. Almost all of these funds came and continue to come from the public coffers (OECD, 1992).

In the past few decades, the role of education in these societies has changed, thus raising new issues and generating virtually ceaseless educational reform movements. Some of these changes, especially those aimed at forging a closer bond between the working world and education, have become known in the region, and an attempt is being made to apply them. The German dual system has probably attracted the most attention of all, and one of the reasons for this is that it alters not only the role and functions of teachers but also their relationship to knowledge and the nature of their own education and advanced training. This innovation is as yet confined to vocational/technical schools.

For the other educational modalities, the classical sort of educational technology still prevails, either in fact or as a frame of reference, despite the instructional and administrative changes that have been made in the schools. The "educational production function", i.e., the combination of human and material resources used to provide education services to the population, does not differ in any essential way from that which was instituted in the nineteenth and early twentieth centuries in the industrialized countries. Although there have indeed been changes in the educational and instructional methods used in the schools, from an economic standpoint there has been no technical progress. Furthermore, today's educational systems are becoming less and less efficient, since the changes in the inputs used to teach each individual has actually raised rather than reduced the cost of obtaining a comparable output.

Figure 1 shows the production function for the most common types of educational systems. The existing combinations, all of which are labour-intensive (T), are located on the AB segment of curve E. The combinations to the left of C (which are more capital-intensive) are purely theoretical; they are not actually found in any existing system. Some of the innovations introduced during the 1970s and 1980s shift the curve towards E' and are therefore less efficient; at all events, they are still situated in the A'B' segment. The problem, from an economic standpoint, is to find a curve that shifts towards E".

FIGURE 1
Production functions for the most common educational modalities



Source: Prepared by the author.

III

Expenditure on the school system

The application of these technologies entails certain costs. In the industrialized countries, these costs are as shown in table 1.

The real level of expenditure per student provides a better idea of the actual cost of educational services than do other commonly-used indicators, such as the percentage of GDP spent on education. Real expenditure takes national conditions into account as they relate to the buying power of education. The cross-country differences shown in table 1 are partly due to differences in the salaries paid to teachers (highest in Sweden and the Netherlands) and to administrative staff (highest in the United States), and in cost-efficiency (highest in Japan). In all these cases, however, teaching methods, the ways in which knowledge is preserved and transmitted, and the relationship between teachers and teaching materials are very similar. This situation is a reflection of different ways of applying the technology, whose costs are influenced by local conditions.

Some of the international agencies which have concerned themselves with this subject, including the World Bank, the Economic Commission for Latin America and the Caribbean (ECLAC) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), have suggested that the amount being spent on education by developing countries should be brought closer to the industrialized countries' levels of expenditure. In aggregate terms, this would be about 6% of GDP.

Table 2, which gives figures for some countries of the region, shows that the levels of expenditure on education, except in the cases of Panama and Jamaica, fall far short of the recommendations of international bodies. The amount of funding allocated for education is reflected, first and foremost, in the level of expenditure per student, which is about ten times lower in the region than in industrialized countries. This gap is not accounted for entirely by these countries' differing levels of development; it is also due to the fact that the countries of the region spend a smaller percentage of their GDP on education and, above all, because they have reduced their costs by various means.

The distribution of expenditure is also interesting, since in most of the countries covered by this analysis it is concentrated in current spending; only Jamaica and Mexico allocate a significant amount of funding for capital expenditures. This type of resource distribution plays a role in determining the way in which this educational technology is applied in the region.

Regardless of the country in which it is applied, this type of educational technology is very intensive in skilled labour. Almost all the countries whose educational systems exhibit these characteristics spend over 60% of the public funds they allocate for education on wages. Some, such as Canada, Germany, France, the Republic of Korea and the United Kingdom, spend over 70% on wages; others, including Argentina, Belgium, Chile and Costa Rica, spend over 80%, while such countries as Bolivia and Colombia spend more than 90% on this item of expenditure.

Capital expenditure represents 5% or less of total spending in the countries of the region, with the exceptions of Jamaica and Mexico, which allocate 13.3% and 38.8%, respectively, of expenditure for investment (UNESCO, 1993). The capital component of expenditure is usually higher in the OECD countries (around 10% of total spending on education in the 1990s).

Aggregate data for spending on education (current and capital expenditure) do not clearly reflect the differences between the industrialized and Latin American countries. Although in the OECD countries the growth rate for current spending has been higher than for capital spending since 1970, this growth has been based on investments made during preceding years. The share of capital investment has fallen from 19.3% to 7.2% in Australia, from 20.0% to 8.5% in Austria, from 20.8% to 7.5% in Germany, from 18.0% to 5.9% in the Netherlands, from 16.1% to 6.5% in Norway, from 22.1% to 10.5% in Switzerland, etc. (OECD, 1992). The elasticity of the increase in current expenditure relative to total spending on education was greater than unity in the 1970s and 1980s, but the share of capital investment then rose in the 1990s, climbing to 10% of public spending on education.

TABLE 1

OECD: Annual public expenditure on education in selected countries
(Average for 1970-1988)

	As percentage of GDP (nominal)	Per student (nominal, in dollars)	Per student (real, in dollars)	Per student nominal, (percentage of per capita GDP)
Australia	5.4	2 693	3 431	25.4
Canada	6.9	4 013	4 106	30.5
United States	4.6	3 520	3 418	21.2
France	5.6[a]	2 254	2 651	...
Germany	4.1	2 039	2 230	20.0
Italy	5.0	1 783	3 284	23.9
Japan	4.7	2 344	2 324	21.4
Netherlands	6.6	2 567	3 158	29.5
Sweden	7.0	4 197	4 358	34.8
Norway	5.6	3 657	3 751	26.1
United Kingdom	4.9	1 758	2 463	21.9

Source: OECD data, 1992.
[a] Percentage of real GDP.

TABLE 2

Latin America and the Caribbean (12 countries): Expenditure on education, 1990

	Total, as percentage of GDP	Current expenditure as percentage of total expenditure	Percentage of current expenditure on secondary education	Expenditure per secondary-school student (nominal, in dollars per year)
Argentina	1.5	96.0	44.9	349.20
Bolivia	2.4	99.5	13.5	61.70
Brazil (1988)	3.9	...	7.2	248.40
Chile	3.4	97.5	17.3	177.30
Colombia (1989)	2.9	95.2	27.6	126.80
Costa Rica	4.6	96.6	17.1	317.30
Ecuador	2.7	94.7	32.0	100.30
Haiti	1.8	99.9	19.1	57.50
Jamaica	5.9	86.7	33.2	251.20
Mexico	4.1	61.2	29.2	257.30
Panama	5.7	97.3	23.3	295.90
Peru (1987)	3.5	94.6	20.4	187.00

Source: UNESCO, 1994.

These variations reflect political and social circumstances in the OECD countries, with the growth of current expenditure being associated with an increase in enrolment rather than with any major changes in the educational technologies being employed. The bulk of the expenditure needed to pay for buildings and teaching materials (libraries, laboratories, etc.) was made in the 1960s and early 1970s. At this point, it is mainly a question –with the exception, probably, of the United Kingdom (except Scotland), Australia and the Scandinavian countries– of refining or upgrading what is already in place. Furthermore, the most important pedagogic innovations (i.e., the various types of comprehensive schools) do not call for radically different educational technologies. This is because they are curricular and structural innovations which do not alter the essential nature of the relationship between teachers and teaching aids or facilities,

although, by doing away with the differentiation of various types of schools, they do make it possible to increase the number of students per teacher.

In Latin America, in contrast, there has been a chronic shortage of investment in physical infrastructure and teaching materials. This state of affairs, whose effects have continued to be felt over the past few decades, has made it possible to run the schools at a lower cost, but the quality of public education has suffered as a result.

IV

Adapting the model to Latin American realities

The major differences between the industrialized nations and the Latin American countries lie in the technological adaptation which has been made in some countries of the region. This adaptation involves the use of almost all of the teacher's workday for teaching classes, while eliminating or minimizing the time spent on reading, lesson preparation, meeting with students, etc. As a result, educational systems end up employing technologies that are more similar to those applied before printed books came into widespread use: in other words, much like those used in the schools that were organized in medieval convents. In this type of school, the instructor is the repository of knowledge, and dictation is the most commonly used technique for transmitting concepts and information. The teacher reproduces –and, at times, comments upon– sentences whose memorization is the objective of the schoolwork performed by students. Students' level of knowledge is monitored by examining how well they remember what was dictated by the teacher, and books, although they do not disappear, cease to play a primary role.

The chief reasons for this type of adaptation today are economic in nature. During a 40-hour week of classes, an instructor can present around 2.5 times more lessons in this type of system than in schools based on the original model. In addition, class size can be larger without creating difficulties since –as this form of teaching does not encourage student participation– it matters less how many students are in the classroom. This lowers the teacher-to-student ratio and therefore improves a school's cost efficiency (as measured by class hours per student), although this does not necessarily mean that it is providing a higher-quality education.

An examination of student/teacher ratios in the late 1980s (see table 3) shows that industrialized countries whose educational systems have a classical organizational structure (i.e., differentiated modalities) generally had fewer students per teacher than those in which comprehensive schools predominated and fewer than in the Latin American and Caribbean countries as well. [2]

Only the former Federal Republic of Germany and France had student/teacher ratios that approached those of countries such as Brazil and Ecuador. In the case of vocational education in Germany, this is accounted for by the special characteristics of its dual school system, which divides up the curriculum between instruction in the classroom and training given by worker-instructors in the relevant industrial establishments, thereby boosting the number of students taught by each teacher in the schools. Moreover, the scale of vocational education is considerable in both of these countries, and this also affects the overall student/teacher ratio shown in the first column of table 3. For these two European countries the student/teacher ratio in non-vocational secondary schools was 11.3. It was 10.1 in the former German Democratic Republic, 9.20 in Italy and 8.27 in Austria. In addition, it must be borne in mind that, in all the European countries with highly differentiated general secondary educational systems, qualitative disparities are to be found between the different tracks, with schools that prepare students for university entrance having a better student/teacher ratio than the upper forms of run-of-the-mill secondary schools.

The student/teacher ratio is precisely one of the aspects of the system that has been changed in Latin America in order to adapt these educational technologies and cut costs. Another major adaptation has been a reduction in the length of the school day. Stu-

[2] These figures provide no more than a rough idea of the situation because they include all teachers, regardless of how many hours they work per week, thereby equating teachers who work 40 hours per week with those who work only a few hours. The figures for countries in which part-time contracts are more common therefore make it appear as though there were more teachers, in relation to the number of students, than there actually are.

TABLE 3

Various regions: Number of students per teacher in secondary schools as of the late 1980s

	Total secondary education	Vocational education
Multi-modal school systems (classical school)		
Belgium (1987)	7.03	...
Austria (1989)	8.45	9.00
German Democratic Republic (1988)	8.96	6.75
Italy (1989)	9.18	9.13
Czechoslovakia (1989)	9.86	7.93
France (1989)	12.42	17.24
Federal Republic of Germany (1988)	14.02	22.26
Comprehensive school systems		
Australia (1990)	12.60	...
United States (1986)	13.35	...
Japan (1989)	17.10	...
Singapore (1980)	19.45	9.18
Republic of Korea (1990)	25.23	21.95
Latin America and the Caribbean		
Ecuador (1987)	14.41	15.49
Brazil (1989)	14.42	...
Mexico (1990)	16.66	13.62
Venezuela (1988)	17.27	...
Panama (1988)	19.41	18.06
Colombia (1989)	19.88	18.00
Peru (1990)	20.92	...
Bolivia (1989)	21.68	...
Jamaica (1988)	26.20	16.49

Source: Based on figures from ECLAC, 1993.

dents in the region's public schools attend between 700 and 900 hours of class per year, whereas in Europe this figure is around 1 200 hours annually and in the Republic of Korea and Japan it is nearly 1 400. Numerous publications in the OECD countries, especially the United States, have advocated the idea that the industrialized countries need to achieve the class-hour levels of Japan in order to rectify the shortcomings of their educational systems.

All the adaptations made in Latin America are associated with low salaries for teachers. If we grant that there is a correlation between wage levels and the technical qualifications of the wage-earner (and that, therefore, higher salaries attract more competent professionals), then the conclusion is that the Latin American educational system is using poorly qualified teachers who are not given any real opportunity to upgrade their qualifications through in-service training or incentives for further study. Even if such incentives were provided, teachers could not make effective use of them because their workloads do not leave them with enough time to participate in such programmes.

The issue of quality is a crucial one in education. The industrialized countries seek to attain it through basic teacher training and subsequent advanced training and refresher courses. Both basic teacher education and advanced training are important components of this pedagogic model.

Although similar measurements for secondary education are not available, there is reason to believe that the gap between the most efficient and the least efficient countries widens considerably at this level, and this is especially true of the United States and the Latin American countries.

V

The educational model under local conditions

The educational policies of a number of countries in the region are aimed at redefining the educational model while at the same time remedying the present situation's adverse effects on the learning process. More often than not, the advocacy of such measures has been based on considerations outside the realm of education, such as the schools' inability to meet the demand for human resources satisfactorily either in the present or the foreseeable future, and a call for changes in the educational system arising out of increasing demands for social equity and democratization (Programme for Better-Quality Education with Greater Social Equity (MECE 1.2), 1993).

The question we need to ask at this point is whether or not it is possible to fashion new educational systems or improve existing ones so that they can do what we expect them to do by applying pedagogic technologies based on the classical school of thought in education and a level of expenditure equivalent to 6% or 7% of GDP. The question is an im-

portant one because the demand for education is very elastic and tends to outpace supply, which has an immediate effect on the quality of this service. Moreover, given the characteristics of education viewed as a "good" which is both a consumer product and an investment, the demand for this good is not regulated by market forces. In other words, variations in the prices paid by users of education are not going to have any direct effect on total demand so long as those users have the option of acquiring this good free of charge or at a very low cost (public education).

In addition, spending more on education does not always improve the quality of educational services. Early studies by Coleman (1966) and Jencks (1972) on the effectiveness of higher spending levels showed that, at the margin, expenditure on school materials and infrastructure has very little bearing on academic achievement. Later studies in the OECD countries on the production functions of education found no consistent relationship between expenditure on education and student performance (OECD, 1992). In the industrialized countries, some authors have raised serious doubts as to whether additional increases in spending –and, if so, to what extent– are the best way to improve the schools' effectiveness. [3]

In order to decide which educational modalities are the most appropriate for the region, we first need to determine the minimum cost structure of the educational technology that serves as our frame of reference and then to compare it with the amounts which the various countries are in a position to, and are willing to, spend. This is not meant to imply that budgetary considerations are the only ones that should play a part in the formulation of policies for this sector, but simply that they must be taken into account.

The industrialized countries apply different versions of the same model. Each has made its own adaptations. Japan and the United Kingdom spend much less, in real terms, than Canada or Sweden do. The Republic of Korea has a student/teacher ratio closer to that of Jamaica or Bolivia, while Japan's ratio is closer to that of Mexico or Venezuela. Nevertheless, the quality of education is far higher in the Asian countries than in Latin America and, according to achievement indicators, than in Europe and the United States too. What we need to determine is where the limits of technological adaptation lie, or in other words, how far we can go in modifying this model without causing the quality of the product (education) to deteriorate (Duran-Drouhin, 1993; Ferreyra, 1993).

The different variations of the educational model can be divided into three main categories: i) the classical sort of differentiated education, which has a number of modalities; ii) comprehensive schools; and iii) the types of schools developed in some East-Asian countries. Schools in the first of the above categories are found in Germany, France, Italy, the Netherlands, etc. The second type of schools corresponds to the United States, Australia, the United Kingdom, the Scandinavian countries and others, while the third variety of schools is to be observed in Japan, the Republic of Korea and Singapore.

The comprehensive systems have more students per teacher than the differentiated systems do, but their level of expenditure is not necessarily lower. Sweden and Norway, in which all secondary education has been organized into comprehensive schools, are among the countries that spend the most on education, no matter which indicator is used as a yardstick.

The East-Asian countries, particularly Japan, the Republic of Korea and Singapore, have also organized their educational systems on the basis of the comprehensive model (Japan) or some degree of differentiation (Malaysia, the Republic of Korea, Singapore). These systems exhibit high levels of academic achievement, and their degree of efficiency is also high, as demonstrated by the fact that their levels of expenditure –measured as a percentage of GDP and as total expenditure per student– are lower than in the industrialized countries. The academic efficiency of these systems is accounted for by the part which the school plays in assigning occupational roles, the importance of having a diploma and, above all, the disciplinary system used by educational institutions. Finally, the school's relationship with the family is very close in regard to both academic and disciplinary matters. These dimensions of the educational system fit in with and are defined by the cultures of these countries.

It would appear that this educational model, as developed in the East-Asian countries, is not an option for the region despite its undeniable comparative advantages in terms of costs. The effectiveness of discipline and ethics-based incentives has been wan-

[3] If the information and means were available to allow us to arrive at proper estimates of the benefits of education (economic, social, educational, etc.), we could then accurately determine the rate of return on investments in this sector. The available information does provide grounds for the hypothesis that the marginal benefits of annual expenditure levels in excess of US$2 000 per student tend to decline to zero.

TABLE 4

Latin America and the Caribbean (10 countries): Requirements for the application of classical educational technology in selected countries

	Additional teaching staff at secondary level[a] (1)	Additional teaching staff at secondary level[b] (2)	1 + 2 as % of number of teachers at the secondary level (3)
Bolivia	11 500	13 100	259
Brazil	95 400	178 400	115
Chile	12 000	9 200	72
Colombia	114 800	15 300	113
Ecuador	21 400	54 000	141
Jamaica	14 500	7 110	240
Mexico	241 500	280 000	130
Panama	8 800	5 300	144
Peru	83 400	38 400	146
Venezuela	42 000	16 300	97

Source: Compiled by the author on the basis of data from UNESCO (1992) and the World Bank (1993).

[a] Estimates based on a teacher/student ratio of 1:10, 1 200 class hours per year and the continuation of existing coverage.

[b] Estimates based on the incorporation into 10 years of formal education of the appropriately-aged members of the population who are not now enrolled, a teacher/student ratio of 1:10 and 1,200 class hours per year.

ing in Latin America's educational system. The absence of a supportive and complementary relationship between the home and the school in the region is another factor that militates against the possibility of using Asian-based strategies for organizing the region's schools.

The information to be derived from the European, Australian or United States systems is more relevant to the region. Using these systems as our frame of reference, we can define the following standards which must be met in order to apply this educational technology effectively:

i) The number of students per teacher should be around 10.

ii) Students should attend 1 200 class hours per year.

iii) Educational coverage, at least up to the tenth grade, should be 100%.

iv) The quality of teachers, as measured by their annual salaries, should be comparable with that of other professionals. Either of the following two types of measurements may be used for this purpose: one involves estimating teachers' salaries on the basis of the average salary of civil servants in professional categories as of 1990; the other uses the starting salary for civil servants in professional categories as a yardstick. [4]

v) Infrastructure (especially buildings) must be expanded in order to accommodate the increases in class time, number of classes and enrolment entailed by the above measures.

vi) Educational institutions need to have suitable libraries.

Meeting these standards would involve different levels of effort on the part of the various countries of the region (see table 4).

In order to improve secondary education in Latin America so as to enable it to meet the demands placed upon it (and assuming that the classical form of school organization is being used), the number of teachers would need to be doubled in the majority of the countries; in some of them, such as Jamaica and Bolivia, two and one-half times more teachers than are currently employed would be needed, with all the costs this implies (see table 5).

The additional amount of current expenditure required on the part of the educational system in order to conform to these parameters would be equivalent to approximately 6.3% of GDP in Ecuador, 2.4% in Brazil, 3.3% in Mexico, 5.8% in Venezuela, 6.2% in Colombia, 4.3% in Peru, 5.0% in Bolivia, 6.9% in Jamaica and 2.2% in Chile. The impact of such a level of expenditure on the economy may be gauged by comparing it with State revenues for 1991 as a percentage of GDP, which amounted to 18.1% in

[4] Information from five countries was used for these calculations; figures for the other countries were obtained by extrapolation.

TABLE 5

Latin America and the Caribbean (10 countries): Expenditure on teachers' salaries in secondary schools and the wage bill for the application of classical educational technology

	Expenditure on secondary-school teachers' salaries (in millions of dollars for the years shown)	Wage bill for secondary-school teachers if classical technology is applied (in millions of 1990 dollars)	
		a	b
Bolivia	...	96.20	72.15
Brazil	632.82 (1986)	5 728.36	4 296.30
Chile	118.76 (1990)	701.42	526.07
Colombia	114.71 (1990)	1 408.87	1 056.65
Ecuador	62.73 (1989)	525.60	394.20
Jamaica	41.14 (1990)	170.07	127.55
Mexico	1 399.10 (1990)	12 015.92	9 011.94
Panama	44.93 (1990)	232.32	174.24
Peru	147.87 (1987)	878.26	658.69
Venezuela	80.57 (1988)	1 033.63	775.22

Source: Compiled by the author on the basis of data from UNESCO (1992) and the World Bank (1993).
[a] Based on an annual teacher's salary equivalent to the average salary of civil servants in professional categories.
[b] Based on an annual teacher's salary equivalent to the starting salary for civil servants.

Ecuador, 14.7% in Mexico, 24.3% in Venezuela, 13.4% in Colombia, 8.3% in Peru, 16.6% in Bolivia and nearly 30% in Jamaica and Chile (World Bank, 1993). Even though investment in education may be considered profitable, it would appear to be impossible for the countries to allocate such large percentages of GDP and of government expenditure to this item alone.

In addition to the considerable increase in current expenditure which the full application of this technology would require, especially with regard to teachers' salaries, it would also call for larger outlays on buildings, libraries and teaching materials. The information needed for estimating these infrastructural expenses is not available, but a look at the experiences of industrialized countries indicates that it would amount to over 20% of total spending on education during the implementation of educational reforms and around 10% thereafter. In view of the condition of the region's infrastructure and its limited coverage, expenditure on these items –especially buildings and libraries– would surely exceed the above-mentioned percentages.

The obvious conclusion is that the classical sort of educational technology cannot be applied in the region on a mass scale: public resources are simply too limited, even if there were a s trong political commitment to assign top priority to education. The successful application of this educational technology by some schools, whose performance levels are similar to those of schools in industrialized countries, does not mean that its use can be generalized. These are private schools or public institutions that enjoy special subsidies which bring their revenues up to the levels seen in industrialized countries, which can offer competitive salaries to teachers and which have adequate infrastructure. Most of the expenditure on private education in the region goes to this type of school, and the resultant benefits are received on an immediate basis by those who are willing to undertake such expenditures. In all likelihood, private expenditure on formal education will continue to be channeled to private schools and the benefits will remain confined to the households in question; this is therefore not a plausible investment option for the school system as a whole. [5]

[5] There is a tendency in the region today to assign all sorts of responsibilities to production firms, including the development of basic skills, which was traditionally the job of the public school system. Peres (1994) suggests that although this may be inevitable under current circumstances, it would seem that, rather than being the outcome of an admirable show of restraint on the part of a non-interventionist State, it is the result of the State's failure to perform some of its basic functions. Similar tendencies are to be observed in the area of health care and in the development of national science and technology systems.

There is another factor to be considered as well: once the industrialized countries' current level of efficiency has been attained, it will be very difficult to improve upon it further. [6] Owing to its intensive use of human resources, it is difficult to raise the productivity of education under this system. There are also other factors that hinder the modification of educational technologies; educational systems tend to protect their teachers' monopoly of the transmission of knowledge, despite the fact that information technology has developed so swiftly in the last 20 years and could be used to much greater advantage. This state of affairs has been perpetuated by high unemployment, since this makes it possible to continue to pay teachers very low salaries.

VI

One possible option: a change in technology

In view of these circumstances, if we are to achieve a form of education that is in keeping with the economic and social demands of today's world and with the region's available or potential resources, we need to explore other options. The strategy employed by the industrialized countries and, to some extent, by the Republic of Korea (during their respective postwar periods) does not appear to be feasible in the region, since it involved an extremely sharp increase in public spending on education within a fairly short period of time, with the sums allocated to education being raised by a factor of 5 or 10 within the space of less than 10 years.

The option(s) for organizing the school system in Latin America must be based on the assumption that expenditure on education, especially by the public sector, needs to be raised above customary levels. Most of the countries in the region could afford to spend between 6% and 7% of GDP, [7] which would have some impacts in certain areas. However, if the existing educational model is maintained, this kind of increase in expenditure will do no more than permit gradual corrections of a general nature to be made, resulting in no more than a slight improvement in performance. Given current conditions and the region's past experience with ongoing marginal modifications, what is needed is what Peres (1994) has called a "structural revolution", inasmuch as the limitations of the educational policy and management strategies applied to date have become evident.

One of the courses of action which should be included in such policies is the development of appropriate educational technologies. The most suitable technology of all has probably not been developed yet, but we do have the materials and the experience needed to set about creating it. It does not seem unreasonable to propose a radical technological change in educational praxis that would enable the countries of the region to move beyond book-based technologies and the classical-school role of the teacher. The idea here would be to make use of the advances in technology and management now being implemented in various spheres of economic and social life, particularly in the areas of the organization of labour and of information-gathering and information distribution (Delker, 1990).

The objective is to bring about technical progress in education by maximizing its capital and labour efficiency while also remaining mindful of existing budgetary constraints. This is curve E" of figure 1. There are probably going to be more actual combinations of resources for these new technologies in curve E" past segment B"C" than those found past segment BC or segment B'C' in curves E and E', which represent the more traditional technologies.

The position of actual technologies on one or another segment of these curves is the result of technical constraints. All the advances made in production technologies, at least since the Industrial Revolution, have involved a transfer of knowledge to machinery, working tools and organization. At this point in time, the educational system has the means to make analogous technical substitutions.

[6] Educational productivity and efficiency are difficult to measure and sometimes hard to define; consequently, policy-makers in this field ofter attribute more importance and allocate more budgetary resources to one component, to the detriment of others, rater than seeking to optimize all the "products" of education.

[7] Nevertheless, some countries whose fiscal revenues are very limited, such as Peru, will need to devise their own technological and financial strategies for developing their educational systems.

Technological innovations designed to boost educational systems' efficiency require industrially-produced teaching materials and methodologies for their use. Hence, teaching aids become the repositories of the knowledge imparted to students, and students come to play a more active role in the process.

Technological innovations involving a more intensive use of capital (and, consequently, an increase in the rate of return on highly skilled labour) do not always require the installation of expensive devices, instruments or infrastructure in each school. Sometimes it is enough simply to reorganize the physical elements of the classroom and to use appropriate materials. There are "light" technologies based primarily on the reorganization of teaching facilities, with a big contribution from outside. There are also –or could also be in the future– "heavy" technologies that require the introduction of instruments and other devices (especially electronic and computer equipment) into the learning process.

The Colombian "escuela nueva" ("new school") system, for example, structures the elementary school on the basis of organizational principles similar to those of the "flexible specialization" approach, which involve such steps as setting up the classroom in units that are analogous to production cells (Kaplinsky, 1984).

The "escuela nueva" has transformed the role of the teacher. In this type of school, teachers no longer need to devote all their time to passing on instructions or information that could simply be written down in a book; instead, their job is to ensure that each student is taking an active part in the learning experience. Students are given independent-study texts containing detailed instructions for each stage of the activity they need to carry out in order to have a truly valuable learning experience. These instructions are drawn up by centres that specialize in curricular development and content and are designed to be given directly to each student; the pupil then studies these materials with a group of three or four classmates and goes to the teacher for help when he or she has difficulty in understanding something. This allows teaching materials to be prepared for a large number of schools which incorporate scientific and pedagogic advances and achieve economies of scale. At the same time, it also frees up teachers for other tasks by cutting down on the amount of time they must spend on simply passing along instructions and information.

The "escuela nueva" has proved to be a very efficient form of teaching and is achieving good results at an expenditure level only 15% higher than that of traditional elementary schools (Schiefelbein, 1992). Chile's Programme for Better-Quality Education with Greater Social Equity (Project MECE 1.2) is another experiment aimed at introducing greater diversity into the basic school system. The merits of experiments such as these are that they entail little additional expense, represent a promising departure from the classical tradition, and are not bound to the European cultural context to which the classical school belongs.

Another area of innovation has to do with the use of personal computers. These pieces of equipment, in conjunction with fibre optics, communications satellites, etc., provide access to information that was previously unavailable to the typical student and enable students to establish long-distance interactive relationships. The cost of these technologies is already low and continues to decrease. Today, a powerful computer costs less than US$1 000, has a useful life of five years and, if used by five students, has an annual per-student cost of just US$40. These costs can be even lower if the schools negotiate effectively with manufacturers. The same is true of software and information. Today a computer equipped with a CD-ROM drive and a compact-disc encyclopaedia is less expensive than the same encyclopaedia would be in book form.

Experiments such as the "escuela nueva" or school activities organized around electronic information media lead to the formation of relationships among students and between them and their teachers which are completely different from those found in the classical type of school. For example, students must get used to working in groups, defining problems, solving them and searching out the relevant information. Teachers cease to serve as the central repositories of knowledge and instead become methodological consultants and organizers of working groups.

This strategy obliges us to re-think the objectives of education. The development of key skills or abilities (problem identification, information search techniques, the ability to measure and classify, logical thinking, learning ability, etc.) takes the place of the earlier objective of providing a solid grounding in certain specific subjects. The use of new educational technologies blurs the dividing line between one discipline and another while also redefining the function, basic preparation and advanced training of teachers.

At the same time, the workings of the educational system need to be structured in such a way as to incorporate other actors that are affected by its performance and that have a valuable contribution to make. This broadening of the system's scope is closely linked to more participatory educational technologies, as exemplified by Germany's dual-module system and Colombia's "escuela nueva". It also makes it possible to establish a relationship between the subjects taught in the schools and the features of development in the region; it thus becomes a matter of "installing" disciplines or subject areas with contributions from the environment in which the school operates. For example, the assistance of the local chemical industry should be sought in delineating how this subject is to be taught in nearby schools, museums could participate in the teaching of art, English-speaking members of the community could help with the teaching of English, etc. The mass media can also play a central role in the incorporation of certain fields of knowledge in school.

Whatever the educational technology or technologies used, and regardless of what kinds of changes are made, the schools will need to try to leap-frog some stages in their efforts to move towards the international technological frontier.

The countries of the region have certain advantages over the European nations in this respect. Paradoxically, because their level of cultural development is lower and because the products and institutions associated with their cultural frame of reference are less accessible than in the industrialized world, the countries of the region are better prepared for a radical change in their educational institutions. A highly developed cultural context has certain advantages in terms of classical schooling and other approaches based on it, but it can also act as an obstacle to innovation.

As mentioned earlier, the largest cost component in the classical model of education, and one of its centrepieces, is the teaching staff. In this discussion we have not factored in the cost of training those teachers, but even if we consider nothing more than teachers' salaries, under adequate conditions for the application of the classical-school model or derivations thereof, such as the comprehensive school, we still reach the conclusion that the countries of the region cannot afford these modalities. Moreover, it is invariably more difficult to increase the productivity of technologies which involve intensive use of human resources, as in these educational systems. The problem becomes even more complicated if the goal is to improve the quality of the "product" or output; the results of the efforts made by the OECD countries over the last 25 years to improve the quality of education by reducing the number of students per teacher and improving the schools' infrastructure and materials have been very unsatisfactory (OECD, 1992). Yet there are some new ways of organizing the schools which, together with the use of electronic media, may enable us to lower costs and set up a form of education that meets current needs.

VII

Technological innovation in education: some policy issues

In the late 1980s and the 1990s, the region has introduced reforms designed to bring about substantive changes in its educational systems. Argentina, Chile, Colombia, Jamaica, Mexico and other nations have launched ambitious reform programmes or have publicly acknowledged the need to do so.

These recent reforms tend to go further than the strategies for change formulated in the 1960s and 1970s, which were based on improvements in one or another modality or level and whose main purpose was to improve the system's coverage within the context of the relevant modality or level and to update content and programmes to meet internal or external demands. Today's proposals are more general in nature and are intended to bring about radical changes, and this is reflected in the formulation of policies which reassign roles and functions to the different social sectors involved.

The educational policies that were structured on the basis of particular modalities or sectors of educa-

tion did have some conceptual advantages and facilitated decision-making. The comprehensive types of proposals being put forward more recently lack this degree of precision and are often watered down into general pronouncements which are confusing or difficult to implement. In such cases, educational policy goes no further than the presentation of general lines of action, while "practical" questions relating to their implementation, including budgetary considerations and technological issues, go unanswered.

A realistic strategy for introducing the necessary changes while also integrating certain general principles should include the above dimensions in the design of the educational system. This translates into the following policies and their corresponding courses of action:

1. Policy A

This policy means taking a firm decision to move in the direction of the technological frontier by taking advantage of the advances made in pedagogy, electronics, computer sciences and communications. The corresponding courses of action would be:

i) To opt for highly cost-effective educational technologies which also substitute capital for labour inputs, whether in the production of teaching aids or in the organization and management of teaching activities themselves.

ii) To narrow the technological gap between the educational systems of the region and those of the industrialized countries by using educational technologies that are appropriate for the countries of the region.

iii) To promote diversity within the educational system by developing subjects or courses of study in the geographic zones where they will be most appropriate, together with the most suitable teaching methods.

2. Policy B

Here, the aim is to promote the transfer, adaptation and development of educational technologies that take existing budgetary constraints into account. The corresponding courses of action would be:

i) To support the formation of strategic alliances among the relevant sectors (teachers, officials of the Ministry of Education, student and parent associations); incorporate new sectors, such as business firms (electronics and communications) and the media (radio, television, the Press); and permit academic sectors to play a more active role.

ii) To seek to achieve the transfer of state-of-the-art educational technology developed outside the region. This involves locating the relevant information and setting up the necessary agencies or prompting existing bodies to translate and adapt methodologies, procedures, textbooks, etc.

iii) To organize programmes for broadening the dissemination of the best educational technologies in the region.

iv) To set up interactive information networks to permit a free flow of communication among all those interested in upgrading the quality of education.

v) To follow up the most promising innovative experiments closely, with regular assessments based on objectives and quality standards, and disseminate the results of those assessments.

3. Policy C

In this policy, the aim is to improve the Government's budgetary appropriations for education in both qualitative and quantitative terms. The corresponding courses of action would be:

i) To increase the government budget for education (without trying to substitute private contributions for government funds).

ii) To apportion the State's budgetary allocation on the basis of realistic, feasible objectives; to this end, cost/benefit studies based on very precise objectives should be conducted and the most efficient strategy defined.

iii) To offer fiscal incentives for research and innovation rather than maintaining the current practice of only providing incentives for greater enrolment.

iv) To define which aspects of education correspond to the private sector and which correspond to the public sector. The identification of the basic skills which it is the responsibility of the State to develop should be one of the starting points for this determination.

4. Policy D

The aim of this policy is to establish State, regional, national or local structures that are capable of carrying out the policies enumerated here. Its purpose is thus to overcome the immobility of most of the re-

gion's Ministries of Education. The corresponding courses of action would be:

i) To create coordinating bodies at the local level and delegate to them the necessary authority to bring together all the interested and/or involved sectors. These bodies should also be able to take the initiative in researching and implementing pedagogic innovations.

ii) To establish permanent or *ad-hoc* agencies to respond to requests for advisory assistance on pedagogic and management innovations.

iii) To make a special effort to forestall major disturbances or misalignments caused by changes in the systems. The analysis of similar cases could be highly instructive in this respect.

5. Policy E

This policy seeks to help to train new and established teachers how to apply new technologies: a primary strategic aspect of any innovation policy. The corresponding courses of action would be:

i) To seek to integrate teachers' colleges and teacher-training institutions in the development of educational technologies and policy-making for the sector.

ii) To organize tours and internships to allow teachers to learn about cutting-edge educational experiments both within and outside the region.

(Original: Spanish).

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