Curricular Content, Educational Expansion, and Economic Growth

AARON BENAVOT

Cross-national studies show that mass educational expansion has a significant positive effect on economic growth, mainly at the primary level, but also at the secondary level.[1] Qualitative features of national school systems such as the provision of textbooks, per-pupil expenditure, and the extent of teacher training also have modest economic effects, especially in the developing world.[2] Debate continues on the array of institutional conditions that accentuates mass education's economic impact.[3]

The present study, by contrast, focuses on a new line of inquiry. It explores the relationship between official curricular policies and long-term economic growth from a cross-national perspective. Specifically, it seeks to determine whether, and to what extent, national variations in curricular content and structure—as distinct from enrollment growth or qualitative provisions—significantly affect economic development. Comparative educational research typically analyzes the curricular content of national school systems according to a three-tiered classification scheme: the official, intended curriculum; the curriculum as implemented in schools and classrooms; and the curriculum as attained by pupils.[4] This study focuses exclusively on the economic consequences of the first tier (the formally prescribed curriculum set forth by national educational authorities)

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[1] John Meyer, Michael Hannan, Richad Rubinson, and George Thomas, "National Economic Development, 1950–70," in *National Development and the World System*, ed. J. Meyer and M. Hannan (Chicago: University of Chicago Press, 1979); David Wheeler, *Human Resource Development and Economic Growth in LDC's*, World Bank Staff Working Paper no. 407 (Washington, D.C.: World Bank, 1980); Pamela Barnhouse Walters, "Educational Change and National Economic Development," *Harvard Educational Review* 51 (February 1981): 94–106; Aaron Benavot, "Education, Gender and Economic Development: A Cross-national Study," *Sociology of Education* 62 (January 1989): 14–32.

[2] Stephen Heyneman and D. Siev-White, *The Quality of Education and Economic Development* (New York: Oxford University Press, 1985); Bruce Fuller and Steven Heyneman, "Third World School Quality," *Educational Researcher* 18 (March 1989): 12–19.

[3] See, e.g., Bruce Fuller, J. Edwards, and K. Gorman, "When Does Education Boost Economic Growth," *Sociology of Education* 59 (July 1986): 167–81; Richard Rubinson and Bruce Fuller, "Specifying the Effects of Education on National Economic Growth," in *The Political Construction of Education*, ed. R. Rubinson and B. Fuller (New York: Praeger, 1992).

[4] R. A. Garden, "The Second IEA Mathematics Study," *Comparative Education Review* 31 (February 1987): 47–68.

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and only for primary education. Based on a sample of over 60 nations (including 43 less-developed countries), it examines the impact of official curricular emphases in eight primary-level subject areas (as measured by average annual hours of instruction) on national economic growth between 1960 and 1985. Mathematics and science education, two curricular subject areas considered by many to be especially important to the economic prosperity of nations, are highlighted throughout this article.

The analyses and findings reported in this study are significant for several reasons. First, they provide a new perspective from which to evaluate the merits of policy reforms such as lengthening the school term or altering instructional time for different types of school subjects, be they general, vocational, practical, or value oriented (e.g., religion, moral education, civics).[5] Second, they entail a preliminary test of the widely assumed, though still unsubstantiated, claim that an emphasis on mathematics and science education in national curricula is a critical precursor of economic prosperity. Third, they indirectly address an issue of great concen to comparative educational research, namely, What are the underlying mechanisms through which mass schooling plays such a pivotal role in the social and economic development of Third World nations?[6]

Curricular Content and Economic Development: Arguments and Evidence

Educational knowledge, organized in the curriculum and transmitted by the public school system, significantly contributes to the economic strength and vitality of a nation. Such a view has long been endorsed by a wide range of academics, politicians, and educators. In early industrializing nations (England, Germany, the United States, and France), state authorities engaged in protracted debates over the design, control, and standardization of school curricula, in part because it was thought that the content of schooling could enhance a nation's competitive standing in the international economic arena.[7] Many believed then that an economically relevant school

[5] On the issue of the length of the school year, see Nancy Karweit, "Should We Lengthen the School Term?" *Educational Researcher* 14 (June/July 1985): 9–15; Michael Barrett, "The Case for More School Days," *Atlantic Monthly* 266 (November 1990): 78–106. On the issue of the economic consequences of different types of school subjects, see an excellent review article by M. J. Bowman, "Overview Essay," *Economics of Education Review* 9 (1990): 283–307, as well as other articles in the issue.

[6] Christopher Colcough, "The Impact of Primary Schooling on Economic Development: A Review of the Evidence," *World Development* 10 (March 1982): 166–85; George Psacharopoulos and Maureen Woodhall, *Education for Development* (New York: Oxford University Press, 1985); Marlaine Lockheed and Adriaan Verspoor, *Improving Primary Education in Developing Countries* (Washington, D.C.: World Bank, 1990).

[7] Ivor Goodson, *School Subjects and Curriculum Change* (London: Croom Helm, 1983); Thomas Popkewitz, ed., *The Formation of the School Subjects* (New York: Falmer, 1987); Herbert Kliebard, *The Struggle for the American Curriculum, 1893–1958* (Boston: Routledge & Kegan Paul, 1986); Jerald Hage, Maurice Garnier, and Bruce Fuller, "The Active State, Investment in Human Capital, and Economic Growth," *American Sociological Review* 53 (December 1988): 824–37; Yun Kyung Cha, "The Effect of Global Integration on the Institutionalization of Modern Foreign Languages in the School Curriculum, 1812–1986" (Ph.D. diss., Stanford University, 1989).

curriculum—that emphasized scientific reasoning, mathematical skills, modern language proficiency, and technical knowledge rather than coursework in classical languages or literature—was needed to ensure a productive work force and a dynamic industrial economy.

Similar beliefs are voiced today. Calls for the reform of national curricular policies are often tied to concerns over a nation's competitiveness in the world economy.[8] Consider the following typical argument that is especially salient today in both the popular press and the speeches of North American political and business leaders: Japanese workers are more productive, manufacture higher-quality goods, and are more committed to the economic enterprise than American workers because Japanese schools are more effective agencies of socialization and training than American schools. Japanese students learn more in school and are better disciplined in the classroom, and these qualities spill over into the workplace. In addition, they are exposed to more academic subjects, especially mathematics and science, which facilitate higher-order cognitive development among pupils; this, in the long run, enhances technological innovation and economic competitiveness. The decline of educational excellence in the United States, so the argument goes, is reflected in its declining share of international markets, its diminishing capacity for manufacturing high-quality goods, and its rising trade deficits. If curricular standards were raised by teaching more "basics" (read: academic courses), and by assigning more hours of homework, then achievement scores would rise, worker productivity would increase, scientific and technological inventiveness would revive, and the United States would eventually regain its competitive edge in the world economy.[9]

In addition, recent cross-national studies of educational achievement are often used to explain (at least in part) past economic growth rates or to foreshadow future ones. The findings of two major comparative research projects are particularly relevant in this regard. The first involves the well-publicized findings of recent International Education Association (IEA) studies of academic achievement in mathematics and science; the second relates to the cross-cultural educational research of H. Stevenson and J. Stigler comparing the academic achievements of Japanese, Chinese, and U.S. elementary students.[10] These two projects, taken together, show

[8] National Commission on Excellence in Education, *A Nation at Risk* (Washington, D.C.: National Commission on Excellence in Education, 1983).

[9] Among many such citations, see those discussed in Beatrice Gross and Ronald Gross, eds., *The Great School Debate* (New York: Touchstone, 1985); Denis Doyle and Marsha Levine, "Business and the Public Schools," *Phi Delta Kappan* (October 1985): 113–18.

[10] Curtis McKnight, Joe Crosswhite, John Dossey, Edward Kifer, Jane Swafford, Kenneth Travers, and Thomas Cooney, *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective* (Champaign, Ill.: Stipes, 1987); International Association for the Evaluation of Education Achievement, *Science Achievement in Seventeen Countries* (Oxford: Pergamon, 1988); Malcolm Rosier, "The Science International Science Study," *Comparative Education Review* 31 (February 1987): 106–

average or below average scores of U.S. and some Western European pupils but significantly higher achievement among Japanese and other Asian students on standardized mathematics and science tests.

Based primarily on cross-sectional analyses performed in these studies, researchers conclude that national variations in academic achievement are significantly related to the organization, distribution, and "intensity" of curricular content. In addition, the basic descriptive findings of these studies lend support to rhetorical arguments, like those noted above, which link the structure of national curricula to economic performance. Thus, despite shaky empirical support, it is received wisdom that national variations in the composition of official and implemented curricula, by their influence on student achievement levels, have important long-term effects on the quality and productivity of the labor force and, consequently, on a nation's competitive position in the world economy.

How valid and logically consistent are such claims? To begin with, when the comparison is limited to Japan and the United States, these arguments have some face validity. Japan has a much longer school year than the United States (240 days vs. an average of 180 days), and, if "extra-school" education and tutoring programs are added to the equation, the typical student in Japan is exposed to significantly more formal instruction in "hard" academic subjects than the typical U.S. student.[11] (This is not necessarily true for each academic subject at a given level of the educational system.) More time spent on instruction, both in school and outside school, is certainly a factor in the superior performance of Japanese pupils on mathematics and science tests and has presumably helped to make the Japanese economy among the fastest growing in the world.

Notwithstanding its intuitive appeal, reasoning along these lines can be faulted on several grounds. First, it ignores salient social and educational differences between the two countries—the dominant pattern of social mobility, the degree of cultural homogeneity, the degree to which school officials and families emphasize effort over innate ability, and so on—differences that may account for subsequent educational *and* economic performance.[12] Second, when a larger sample of countries is examined,

28; Kenneth Travers and Ian Westbury, *The IEA Study of Mathematics I: Analysis of Mathematics Curricula* (Oxford: Pergamon, 1990); Harold Stevenson, S. Lee, and J. Stigler, "Mathematics Achievement of Chinese, Japanese and American Children," *Science* 231 (February 1986): 693–99; James Stigler, S. Lee, G. Lucker, and H. Stevenson, "Curriculum and Achievement in Mathematics," *Journal of Educational Psychology* 74 (June 1982): 315–22.

[11] V. Kobayashi, "Japanese and U.S. Curricula Compared," in *Educational Policies in Crisis*, ed. W. Cummings, E. Beauchamp, S. Ichikawa, V. Kobayashi, and M. Ushiogi (New York: Praeger, 1984).

[12] Nobuo Shimahara, "Japanese Education and Its Implications for U.S. Education," *Phi Delta Kappan* 66 (February 1985): 418–21; U.S. Department of Education, *U.S. Study of Education in Japan* (Washington, D.C.: Government Printing Office, 1987); B. Fuller, S. Holloway, H. Azuma, R. Hess, and K. Kashiwagi, "Contrasting Achievement Rules," in *Research in Sociology of Education and Socialization*, vol. 6, ed. A.Kerckhoff (Greenwich, Conn.: JAI, 1986).

the relationship between total instructional time (or length of the school year) and national educational achievement weakens considerably, at least in the area of mathematics.[13]

Third, and perhaps most significant, even if it can be shown that actual instructional time, the length of the school year, or other features of the national curriculum have a strong impact on levels of student achievement, this does not necessarily corroborate the claim that student proficiency in certain school subjects contributes to economic growth. The latter argument, which is based on aggregate-level causal effects, cannot be conclusively validated by evidence of individual-level effects.[14] The fact that students, while in school, achieve high scores in certain academic subjects does not necessarily mean that such demonstrable proficiencies persist over the life-cycle or are effectively applied on entering the workplace. Indeed, this presumption of long-term socialization effects is especially suspect in countries where the credentials students acquire carry more weight than the actual knowledge they may have gained through schooling.[15]

Conversely, if structural features of national school systems are shown to have weak or no effects on academic achievement as measured by standardized tests, this does not necessarily mean that the former are unrelated to national economic performance. For example, by increasing student interest in postsecondary programs in science, engineering, or technology, or by influencing student attitudes toward and public support for government investment policies in science and technology or basic research and development, features of the school curriculum could have long-term economic effects despite relatively low achievement levels. In short, there is a dearth of well-designed comparative studies that directly address the basic issue: do variations in national curricular policies, independent of student achievement levels, have significant, aggregate-level impacts on macroeconomic change?

Curricular Reforms in Less Developed Nations

While arguments concerning the economic impact of school curricula have been intensely debated in advanced, industrialized nations, they have special relevance in the context of the developing world. The school curricula of newly independent nations, once largely shaped by the interests of European colonial powers and missionary groups, were reevaluated and often restructured in the light of a diverse array of new purposes: forging national unity, training highly skilled manpower, spreading literacy

[13] McKnight et al.

[14] John Meyer, "The Effects of Education as an Institution," *American Journal of Sociology* 83 (March 1977): 55–77; Charles Bidwell and John Kasarda, "Conceptualizing and Measuring the Effects of School and Schooling," *American Journal of Education* 88 (1980): 401–30.

[15] Randall Collins, *The Credential Society* (New York: Academic Books, 1979).

throughout the population, promoting "modern" values and attitudes, and advancing the cause of economic development. Still, at the level of the official intended curriculum (i.e., what subjects should be taught and how they should be distributed during the school week), the achievement of national sovereignty did not always have marked consequences. Many newly independent countries instituted only minor changes in colonial school curricula; others simply imported new curricular materials from metropolitan centers.[16]

Nevertheless, many less developed nations undertook significant curricular reforms to reorganize the content of mass education. Especially pronounced was the push to integrate "modern" school subjects with scientific and mathematical content together with older subject emphases on religion, language, and practical training. Since the 1960s, for example, virtually all developing countries have mandated some form of mathematics and science instruction in public elementary schools. At the lower secondary level (grades 7–9), these two subject areas have become ubiquitous elements in the school curricula of developing countries, taking up a third or more of the total time allocated to all school subjects.[17]

To examine more closely the nature of recent curricular reforms in the developing world, table 1 presents detailed evidence concerning the place of mathematics and science education in official school curricula by world region. The top two sections of the table present evidence concerning the elementary level (grades 1–6); the bottom section reports recent data for the lower secondary level (grades 7–9). In the area of mathematics education, developing countries in all regions increased both the relative emphasis on and the average annual hours of instruction devoted to this subject between 1960 and 1980 (see the top sections of table 1). Curricular time allocated to science education also grew, although the two developing regions which devoted the most instructional time to this subject in 1960 (Latin America and Asia) slightly reduced time allocations in the 1980s. Especially noteworthy is the fact that less developed nations placed *greater* curricular emphasis on elementary science than more developed Organization for Economic Cooperation and Development (OECD) nations.[18] In lower secondary school curricula, the emphasis on mathematics and

[16] Brian Holmes and Martin McLean, *The Curriculum: A Comparative Perspective* (London: Unwin Hyman, 1989).

[17] David Kamens and Aaron Benavot, "Elite Knowledge for the Masses: The Origins and Spread of Mathematics and Science Education in National Curricula," *American Journal of Education* 99 (February 1991): 137–80; Unesco, *The Place of Science and Technology in School Curricula: A Global Survey* (Paris: Unesco, 1986).

[18] Regional variation at the primary level is apparent but relatively small: mathematics and science education are given somewhat more emphasis in the Latin America/Caribbean region and somewhat less emphasis in the Middle East and North Africa. Modest regional variation in these two subject areas is also noticeable in the official curricula of lower secondary grades (see the bottom section of table 1).

TABLE 1

CURRICULAR EMPHASES ON MATHEMATICS AND SCIENCE EDUCATION AT THE PRIMARY AND LOWER SECONDARY LEVELS, 1960s–1980s, BY WORLD REGION (Constant Cases)

	Latin America/ Caribbean	Asia	Sub-Saharan Africa	Middle East/ North Africa	OECD Countries*	Totals
A. Proportion of the official primary curriculum devoted to mathematics and science education:						
Mathematics:						
1960	18.6 (13)	15.2 (14)	15.1 (15)	15.9 (17)	17.9 (20)	16.6 (79)
1980	19.1 (13)	17.9 (14)	17.5 (15)	17.0 (17)	19.3 (20)	18.2 (79)
Sciences:						
1960	10.5 (13)	8.6 (14)	5.2 (15)	6.9 (17)	6.1 (20)	7.3 (79)
1980	11.6 (13)	7.6 (14)	7.1 (15)	7.6 (17)	6.8 (20)	7.9 (79)
B. Average annual hours of instruction in mathematics and science at the primary level:						
Mathematics:						
1960	168.2 (7)	130.9 (11)	128.4 (7)	130.4 (13)	167.5 (17)	146.5 (55)
1980	171.8 (7)	156.7 (11)	151.8 (7)	149.6 (13)	170.7 (17)	160.6 (55)
Sciences:						
1960	88.3 (7)	71.9 (11)	54.8 (7)	53.2 (13)	56.4 (17)	62.6 (55)
1980	85.3 (7)	62.6 (11)	66.0 (7)	68.1 (13)	58.8 (17)	65.8 (55)
C. Emphasis on mathematics and science education at the lower secondary level (1980s only):						
Mathematics:						
%†	14.5 (17)	14.9 (10)	16.5 (18)	13.5 (17)	14.0 (16)	14.7 (78)
Weekly hours‡	12.5 (19)	12.1 (10)	13.3 (19)	11.5 (17)	11.8 (17)	12.3 (82)
Sciences:						
%†	17.0 (17)	17.8 (11)	14.6 (18)	13.3 (16)	16.7 (16)	15.7 (78)
Weekly hours‡	13.6 (18)	14.2 (11)	11.7 (19)	11.1 (17)	14.0 (17)	12.8 (82)

NOTE.—Unweighted averages are reported; number of cases is in parentheses.
* This category includes Western Europe, North America, Australia, and New Zealand.
† This row refers to the percentage of the official lower secondary curriculum devoted to each subject.
‡ This row refers to the average weekly hours of instruction at the lower secondary level in each subject.

science among developing countries is also considerable, both in absolute terms and relative to more developed nations (refer to bottom section of table).

Overall, the data clearly show that nations around the world, especially in the Third World, have allocated substantial—and, in most cases, increasing—amounts of instructional time to mathematics and science, the two subject areas thought to have the greatest relevance to economic and technological development. Even though there is little conclusive scientific evidence confirming their long-term economic effect, mathematics and science education have become core components of mass school curricula. The underlying rationale for this trend has been facilitated by several justificatory logics: for example, exposing young people to the basic principles of science and mathematics is necessary to promote the idea that the world is empirical and lawful and governed by natural forces, or, pupils need to learn that the assimilation of scientific knowledge, as well as its development and utilization in modern technology, is important because it can improve the quality of life of individuals, communities, and nations.[19] While different justifications have been put forward by different developing countries, the end result is the same. Specifically, there is a growing emphasis on exactly those "modern" curricular subjects that appear most likely to enhance long-term development prospects.

Thus, an abiding article of faith among the nations of the world is to ensure that young people are exposed to the rudimentary principles of mathematics and science. At the same time, a dominant educational ideology has been constructed (and apparently institutionalized worldwide) that directly links the content of schooling to a range of societal outcomes such as economic growth, scientific productivity, and technological progress.[20] Does this ideology have any basis in fact? Does an emphasis on modern curricular content such as mathematics and science contribute to economic development, discounting other factors? If so, is this relationship limited to certain types of countries? The analyses and findings reported in the following sections address precisely these questions. Using a cross-national and longitudinal research design, the analyses explore whether national variations in annual instructional time devoted to mathematics and science as well as six other subject areas had positive effects on economic growth during the 25-year period from 1960 to 1985. They also examine whether the economic effect of different school subjects vary among more and less developed countries.

[19] Unesco Regional Office for Education in Asia and the Pacific, *Science Education in Asia and the Pacific* (Bangkok: Unesco, 1984).

[20] See also Robert Fiala and Audrey Gordon-Lanford, "Educational Ideology and the World Educational Revolution, 1950–1970," *Comparative Education Review* 31 (August 1987): 315–32.

Data Sources

Most cross-national data employed in this study were taken from widely available national account statistics published by the United Nations, Unesco, and the World Bank.[21] The main dependent variable, economic growth, was measured by national estimates of per capita real gross domestic product (RGDP) in constant 1980 international prices.[22] For the purposes of cross-national research, this variable appears to be superior to the more widely used measure, gross national product (GNP), since it incorporates more realistic and comparable estimates of national income levels and purchasing power parities. Since the distribution of per capita RGDP is positively skewed, like most other measures of economic development, it was logged in all the analyses reported below.

Apart from the main explanatory variables that refer to annual instructional hours in different curricular subjects, several other independent and control measures were entered in the models. Two measures of the expansion of mass education were employed—the primary and secondary enrollment rates, respectively—which refer to the proportion of the relevant school-age population enrolled in the lower two levels of the educational system.[23] In addition, three other control measures were included since previous cross-national studies found them to have significant effects on economic growth rates: (1) population growth, measured by the total fertility rate and expected to have negative effects on economic development; (2) export commodity concentration (i.e., the current value of the three major export commodities of a country as a percentage of the total current value of merchandise exports), and one aspect of economic dependence expected to negatively affect economic growth; and (3) a "dummy" variable for nations whose economies were highly dependent on oil and mineral exporting, generally assumed to have a positive effect on economic growth.[24]

Information concerning official primary school curricular policies came from a wide array of published sources. A considerable amount of curricular data was gathered from published reports of international agencies linked to Unesco; other data were coded from comparative educational handbooks and encyclopedias, historical surveys of national and colonial educational

[21] United Nations, *World Population Trends, Estimates and Projections as Assessed in 1984* (New York: United Nations, Department of International Economic and Social Affairs, 1986); Unesco, *Statistical Yearbook* (Paris: Unesco, 1970); World Bank, *World Tables*, 3d ed. (Washington, D.C.: World Bank, 1983).

[22] Irving Kravis, Alan Heston, and Robert Summers, *World Product and Income: International Comparisons of Real Gross Product* (Baltimore: Johns Hopkins University, 1982); Robert Summers and Alan Heston, "A New Set of International Comparisons of Real Product and Price Levels Estimates for 130 Countries: 1950–1985," *Review of Income and Wealth* 34 (March 1988): 1–25. It should also be noted that similar results obtained, though for a slightly smaller sample, when per capita GNP was employed as the dependent variable instead of per capita RGDP.

[23] Unesco, *Statistical Yearbook.*

[24] United Nations, *World Population Trends;* World Bank, *World Tables.*

systems, contemporary case studies of educational developments in particular countries, and two sets of microfiche from the International Bureau of Education (IBE).[25] Curricular information for some countries was supplemented from official correspondence and national publications received during a 1985 survey of over 150 national ministries of education. (Approximately half of the ministries sent replies, of varying length and detail, with information on curricular policies and plans.) A detailed listing of all the sources used in this study can be found elsewhere.[26]

Two basic pieces of infomation were coded from these sources: first, a list of the subjects taught during the elementary school cycle in each country; second, the number of school periods or school "hours" devoted to each subject during the primary school cycle.[27] This coding procedure produced two types of variables for each subject: a dichotomous variable that simply notes whether or not a particular subject was taught in the official curriculum, and a continuous interval variable indicating the proportion of total school periods that each subject was taught during the first 6 years of primary education. Data on these variables were then grouped according to historical period (e.g., 1945–69, 1970–86) depending on when the coded curricular timetable was in effect.

In addition to these two curricular measures, a third, more "refined" indicator of official curricular emphases was developed. Rather than measure the relative emphasis of each subject in the national curriculum (e.g., the proportion of total curricular periods devoted to mathematics or science education), it estimated the allocated amount of time (in yearly hours) that pupils were exposed to instruction in each subject area during each year of the primary school cycle. Recent reports as well as some earlier studies suggest that cross-national variation in annual instructional time is quite marked.[28] Thus, for example, while the relative emphasis on mathematics or science in the official primary curriculum may change

[25] International Bureau of Education (IBE) and Unesco, *National Reports to International Conference on Education, 39th Session,* microfiche (Geneva: IBE and Unesco, 1984), *National Reports to International Conference on Education, 40th Session,* microfiche (Geneva: IBE and Unesco, 1986).

[26] Kamens and Benavot (n. 17 above); and Aaron Benavot and David Kamens, *The Curricular Content of Primary Education in Developing Countries.* Policy, Planning, and Research Working Paper no. 237 (Washington, D.C.: World Bank, 1989).

[27] Each curricular subject listed in an official timetable was coded into one of eight general categories: combined language education (reading and writing in national, official, local, foreign, and/or classical languages), mathematics, sciences, combined social sciences (social studies, history, geography, civics), combined moral and religious education, aesthetic education (music, arts, drawing, dance), physical education, and prevocational education or practical subjects (manual training, industrial arts, agriculture, domestic science, vocational education, and business). Curricular time in elective subjects and in various "peripheral" activities (e.g., hygiene, recreation, extracurricular activities, recess, miscellaneous) was coded as "other" and not incorporated in the present study. A combined category means that instruction was offered in either one or all of the specific curricular topics listed in that category.

[28] See, e.g., McKnight et al. (n. 10 above), p. 53; Unesco, *The Place of Science and Technology in School Curricula: A Global Survey* (n. 17 above); Robert Dottrens, *The Primary School Curriculum* (Paris: Unesco, 1962).

slowly over time or vary quite modestly over national space, measures of the number of hours mathematics or science subjects are taught each year vary more markedly.

In order to develop national estimates of annual instructional time per subject area, data sources were coded for information on the length of the school year (in weeks or days), the length of the school week (in weekly school periods or actual hours of instruction), and the length of a school period (in fractions of hours). Combining previously coded curricular information with this new information, estimates of average annual hours of instruction for each subject area were constructed for about 80 nations in the 1945–69 period and some 100 nations in the 1970–86 period. These figures refer to the number of formal instructional hours that a typical primary school student is expected to receive each year in a given subject area. Whenever possible, school time set aside for recesses, breaks, assemblies, and the like was excluded. Although some error is inherent in data of this kind, there is good reason to believe that they permit reasonably valid and reliable comparisons across national polities.[29]

Finally, there is substantial literature that claims that students learn more when they are exposed to more overall instruction, when they are exposed to more instruction in a particular subject area, or when they spend more of the allocated time "on task."[30] It is possible, then, to draw the following two inferences: first, nations gain more, in economic or political terms, when their mass school systems require more total hours of formal instruction (or more hours in an especially relevant subject); second, nations gain more when they expose grater numbers of students to greater amounts of formal instruction. The first inference assumes an additive effect of instructional time, whereas the second one assumes a multiplicative effect. Both of these ideas will be tested in the cross-national analyses to follow.

The Meaning and Weaknesses of Official Curricular Data

The curricular data employed in this study are based on official policy declarations of subject categories to be taught in primary schools, generally produced by government education officials in the form of national timetables and syllabi. Quantitative measures derived from such official timetables represent a limited and rather incomplete picture of the rich array of detailed topics, textbooks, and pedagogical practices that embody the curriculum of national school systems. Official statements of curricular policy can be (and many times are) poorly related to local educational

[29] For further discussion of how these figures were estimated, see Kamens and Benavot.

[30] Charles Fisher and David Berliner, *Perspectives on Instructional Time* (New York: Longman, 1985); Joseph Murphy and Philip Hallinger, "Equity as Access to Learning: Curricular and Instructional Treatment Differences," *Journal of Curriculum Studies* 21 (March–April 1989): 129–49; and Karweit (n. 5 above).

practices. This "slippage" or "loose coupling" between the intended and the implemented curriculum has been noted in both centralized and decentralized educational systems in the industrialized world and is assumed to be even more salient in the educational systems of developing nations.[31]

If the gap between educational rules and classroom reality is so pronounced, why study the effects of official curricular policies? First, and most obvious, official policies of what children are to study reflect national commitments widely understood, both internally and externally, as carrying authoritative intent. At a minimum, official definitions impinge on the formal organization of local school systems. Certain bodies of school knowledge are officially authorized; others are not. The approved content areas are distributed throughout the days and years of the schooling cycle according to relatively explicit goals and objectives. National differences in official time allotments to particular subject areas are apt to reflect genuine differences in subject emphases and educational philosophies and deserve to be studied. Second, under certain conditions, official curricular policies may closely approximate the actual curricular content of local schools. For example, when there is strong normative consensus between local teachers and national administrators over what should be taught in the classroom, or when local schools encounter tight administrative controls over classroom practices and procedures, the gap between the official and implemented curriculum may be relatively small.[32]

Having said this, there are other reasons to think that official data obscure more than they reveal. For instance, if official policies concerning the curriculum are simply ideological statements intentionally formulated by national educational leaders in the Third World to reflect the "proper" educational standards of international donor agencies (since it is they who make critical decisions regarding educational loans and grants), then the data may show no more than superficial patterns of worldwide conformity. To be sure, national timetables and curricular standards are determined, in part, by external worldwide conventions, though not necessarily those embedded in international donor agencies. Recent research suggests that there was considerable similarity (convergence) in official curricular policies *prior* to the establishment of international educational and development agencies such as Unesco, IBE, and the World Bank.[33] In fact, there is

[31] For industrialized countries, see Karal Weick, "Educational Organizations as Loosely Coupled Systems," *Administrative Science Quarterly* 21 (March 1976): 1–19; John Meyer and Brian Rowan, "Institutionalized Organizations: Formal Structure as Myth and Ceremony," *American Journal of Sociology* 83 (September 1977): 440–63; David Baker and David Stevenson, "State Control of the Curriculum and Classroom Instruction," *Sociology of Education* 64 (January 1991): 1–10. For developing countries, see Hugh Hawes, *Curriculum and Reality in African Primary Schools* (Bristol: Longman, 1979); Lockheed and Verspoor (n. 6 above).

[32] See Baker and Stevenson.

[33] Aaron Benavot, Yun-Kyung Cha, David Kamens, John Meyer, and Suk-Ying Wong, "Knowledge for the Masses: World Models and National Curricula, 1920–1986," *American Sociological Review* 56 (February 1991): 85–100; Kamens and Benavot.

little direct evidence to support the claim that the official curricular policies of developing countries, especially at the elementary level, have been extensively imposed by external agencies. In any case, there are significant cross-national differences in official curricular categories and subject emphases, and it is interesting to examine whether these differences have long-term effects on important societal changes such as economic growth.

Research Design and Methodology

The present cross-national study attempts to establish causal relations between variable features of social units (in this case, nations) using a nonexperimental research design. The defining feature of this type of comparative research is its use of attributes of macrosocial units in the explanatory statements.[34] As in previous cross-national research of economic growth, this study uses aggregate, national-level data. The units of analysis are countries; the sample size depends on the data coverage of the variables included in the models.

This study employs a multiple regression methodology using panel data.[35] Panel regression analysis incorporates both variation between nation-states and variation over time. It entails regressing the dependent variable at a later time point (t_2) on the same variable measured at an earlier time point (t_1) and on a series of independent variables also measured at the earlier time point (t_1). In the present study, a 25-year panel design is used in which the level of economic development at 1985 is regressed on itself at 1960 (the "lagged dependent variable"), on measures of instructional time devoted to different school subjects at 1960, and on several control variables also measured about 1960.[36]

Analyses are performed separately for all nations and for a smaller sample of less developed Third World nations to check for differential effects. Since data coverage on most of the above measures (except for curricular emphasis) is quite extensive, the "sample" of countries from different world regions, except sub-Saharan Africa, is fairly representative. The Appendix lists the specific countries included in the analyses.

Findings

This section begins by surveying selected descriptive statistics of the main explanatory variables used in the panel regression models. Table 2

[34] Charles Ragin, *The Comparative Method* (Berkeley and Los Angeles: University of California Press, 1987).

[35] Discussion of the advantages of panel regression models for cross-national analysis can be found in Michael Hannan, "Issues in Panel Analysis of National Development," in Meyer and Hannan, eds. (n. 1 above); Nancy Tuma and Michael Hannan, *Social Dynamics: Models and Methods* (Orlando, Fla.: Academic Press, 1984).

[36] A shorter panel design in which the economic effects of curricular policies were examined in a 15-year period (1960–75) produced results nearly identical to those reported in the article.

TABLE 2
MEANS AND STANDARD DEVIATIONS FOR ALL VARIABLES IN PANEL ANALYSES BY LEVEL OF DEVELOPMENT

	All Countries (N = 63)		More Developed Countries (N = 20)		Less Developed Countries (N = 43)	
	Mean	SD	Mean	SD	Mean	SD
Log of per capita RGDP:						
1985	3.40	.46	3.89	.15	3.18	.37
1975	3.35	.42	3.80	.15	3.13	.34
1960	3.15	.38	3.56	.20	2.96	.29
Mean yearly instructional hours (circa 1960):						
All elementary school subjects:	870.8	163.6	917.0	154.8	849.3	164.9
Language education	305.6	109.3	350.0	74.2	284.9	117.3
Mathematics	144.5	40.4	167.5	44.5	133.8	33.9
Sciences	63.3	42.3	62.4	37.1	63.7	44.9
History, geography, social studies, civics	75.6	36.5	71.1	37.6	77.7	36.2
Arts, music, dance	81.2	36.3	92.9	30.3	75.8	37.9
Physical education	58.7	30.3	66.6	31.6	55.0	29.3
Religion, moral education	50.5	43.3	47.6	46.4	51.8	42.3
Prevocational, practical subjects	65.4	69.2	46.4	47.1	74.2	76.2
Primary enrollment ratio, 1960	77.4	27.3	96.3	5.9	68.7	29.0
Secondary enrollment ratio, 1960	24.2	19.0	44.8	13.7	14.6	12.5
Total fertility rate, 1965	4.9	1.9	2.5	.44	6.0	1.1
Dummy variable for mining/oil exporters	.13	.34	.00	.00	.19	.39
Export commodity concentration, 1960	46.4	30.2	17.6	15.5	59.8	25.6

NOTE.—SD = standard deviation; RGDP = real gross domestic product.

shows that in 1960 nations required, on the average, 870 hours of formal instruction during each year of primary schooling. Overall hours of instruction were somewhat higher among more developed countries (917.0 hours per year) than among less developed countries (849.3 hours per year). The three R's comprised about half of all instructional hours: reading and writing (i.e., language education) received over 300 hours of instruction; arithmetic and other math-related subjects about 145 hours of instruction. The remaining instructional hours were distributed among a series of "core" subjects that were required in almost all countries and several "peripheral" subjects that were required in less than three-fourths of all countries.[37] Core subjects included art and music (81.2 hours per year), history, geography, and social studies (75.6 hours/year), natural sciences (63.3 hours/year), and physical education (58.7 hours/year). Peripheral subjects included religion and moral education (50.5 hours/year) and prevocational or practical subjects (65.4 hours/year). (Practical subjects were defined in this study as courses in manual training, agriculture, domestic education, and gardening.) Differences in average time allocations by level of development were minimal in the subject areas of science and religion and moral education, as well as in the combined area of history, geography, and social studies. In the remaining subject areas, more developed nations allocated more hours of instruction to aesthetic education and physical education and less hours to prevocational education than less developed nations in the Third World.

Table 3 presents zero-order correlations among all the variables employed in the panel analysis. Associations between most curricular emphases and levels of economic development are weak and nonsignificant. Two subject areas, mathematics and physical education, have positive, but not especially strong, associations with economic development; prevocational education is negatively correlated with economic development. Correlations between each of the other independent variables (i.e., primary education, secondary education, fertility rates, and export commodity concentration) and economic development are strong and in the expected direction. Although table 3 reports relatively high intercorrelations among several independent variables (which could be a potential source of multicollinearity), these were later checked using a series of regression diagnostics and found to have no adverse effect on the main pattern of results reported below.[38]

Turning to the panel regression analyses, three different models were estimated. The first model estimated a baseline equation in which level of economic development in 1985 was regressed on level of economic development in 1960, the primary and secondary enrollment rates for 1960, and the previously mentioned control variables. The second model reestimated this baseline equation but added a single measure for overall yearly instructional time at the primary level (i.e., total hours of instruction across all subject areas). The third model estimated the economic effects of instructional time allocated to eight different subject areas (mathematics, science, language, art/music, social science, religion/moral education, physical education, and prevocational education) after controlling for the influence of educational expansion, fertility rates, high-income oil exporters,

[37] Benavot et al.

[38] See Eric A. Hanushek and John E. Jackson, *Statistical Methods for Social Scientists* (New York: Academic Press, 1977); David A. Belsley, Edwin Kuh, and Roy E. Welsch, *Regression Diagnostics: Identifying Influential Data and Souces of Collinearity* (New York: Wiley-Interscience, 1980).

TABLE 3

Correlation Matrix of Variables Used in Panel Regression Analyses

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1. RGDP per capita, 1985	. . .	.93*	.78*	.84*	.14	.37*	−.01	.14	.20	−.02	.24*	.04	−.24*	−.81*	−.08	−.66*
2. RGDP per capita, 1960	.85*		.69*	.82*	.13	.39*	−.06	.14	.12	−.02	.23*	.05	−.17	−.80*	−.07	−.58*
3. Primary education, 1960	.73*	.61*		.66*	.03	.39*	.04	.01	.16	−.05	.13	.13	−.22*	−.63*	−.06	−.39*
4. Secondary education, 1960	.77*	.74*	.60*		.08	.20	−.03	.04	.20	.08	.22*	.02	−.09	−.84*	−.19	−.64*
5. Total instructional hours	−.04	−.09	−.05	.00		.52*	.36*	.51*	.20*	.36*	.50*	.08	.26*	−.19	.05	−.09
6. Math instructional hours	.22	.21	.37*	.11	.42*		.22*	.32*	.00	−.05	.37*	−.10	−.07	−.39*	.10	−.19
7. Science instructional hours	.01	−.06	.06	−.10	.42*	.35*		−.34*	.14	.31*	.25*	−.10	.33*	.01	−.00	.16
8. Language instructional hours	−.11	−.15	−.16	−.22	.46*	.10	−.33*		−.13	−.18	.04	.03	−.36*	−.18	.07	−.22*
9. Arts instructional hours	.06	−.09	.07	.04	.21	.02	.11	−.16		.23*	.39*	−.22*	−.06	−.26*	.15	−.17
10. Social science instructional hours	.08	.13	.02	.20	.53*	.27*	.46*	−.16	.20		.12	−.14	.24*	.02	.00	.09
11. Physical education instructional hours	.18	.14	.11	.31*	.38*	.22	.22	−.07	.44*	.16		.03	.06	−.28*	.02	−.25*
12. Moral/religious instructional hours	.05	.04	−.15	.10	.05	−.06	−.13	.07	−.40*	−.21	.12		.01	.08	−.07	−.02
13. Vocational instructional hours	−.17	−.05	−.14	.14	.21	−.18	.32*	−.44*	.03	.33*	−.01	.00		.14	−.06	.19
14. Total fertility rate, 1965	−.54*	−.53*	−.52*	−.72*	−.07	−.21	.02	.12	−.09	−.10	−.29*	.08	−.09		.23*	.70
15. Dummy for mining/oil countries	.16	.21	.07	.00	.12	.30*	−.01	.16	.24	−.02	.09	−.10	−.12	.00		.38
16. Export commodity concentration	−.35*	−.14	−.12	−.37*	.04	.16	.22	−.11	.00	.06	−.13	−.14	.06	.36*	.32*	. . .

Note.—The sample of developed countries is above the diagonal; the sample of less developed countries is below the diagonal; RGDP = real gross domestic product.

* Zero-order correlations are significant at least at the .05 level.

and commodity concentration. Each of these three models was estimated for the full sample of countries (table 4) and for a smaller sample of less developed countries (table 5).

The economic impact of interaction effects between curricula time allotments and the level of educational expansion at the primary level was also analyzed (tables 6 and 7). By multiplying the primary enrollment rate with the number of annual instructional hours in each subject area, a series of interaction (or multiplicative) measures were constructed that estimate what percentage of students in each nation were exposed to how many hours of formal instruction in each subject area.[39] In both additive and multiplicative models, only unstandardized regression coefficients are reported; instances in which these regression coefficients are either 1.5 times or twice their standard error are reported as significant.

The baseline model estimated in table 4 (eq. [A]) shows that educational expansion at both the primary and secondary levels has a significant positive effect on economic growth between 1960 and 1985. This finding confirms the results of previous cross-national studies.[40] Each of the control variables is significant and in the expected direction except for the total fertility rate: not only is this indicator of population growth nonsignificant, but, in contrast to previous cross-national studies of economic growth, the coefficient is positive. This may be due either to the particular sample of countries included or, more likely, to the historical period under examination. In either case, there is no evidence that this variable has adversely influenced the pattern of curricular effects.

The main findings from table 4 show that the economic impact of total yearly hours of instruction across all subject areas is positive, but not significant (eq. [B]). When this measure is broken down by subject area (eq. [C]), two of the eight subject areas have significant effects on economic growth: science education (a positive effect) and prevocational or practical education (a negative effect). Given the unquestioned centrality of science in educational reform proposals, and the extensive literature on the "vocational schooling fallacy" in comparative educational research, the positive effect of science education and the negative effect of prevocational education should come as no surprise.[41] However, contrary to the widespread attention given mathematics and language education in both the popular and scholarly press, there is no evidence that instructional hours allocated to either elementary mathematics or language significantly

[39] These indicators are analogous to measures of the "yield" or "productivity" of an educational system that have been employed in the recent IEA studies of mathematics achievement such as McKnight et al. (n. 10 above), p. 61.

[40] See John Meyer et al. (n. 1 above); Aaron Benavot, "Educational Expansion and Economic Growth in the Modern World System, 1913–1985," in Rubinson and Fuller, eds. (n. 3 above).

[41] Rosier (n. 10 above); Bowman (n. 5 above); Philip Foster, "The Vocational School Fallacy in Development Planning," in *Education and Economic Development*, ed. C. A. Anderson and M. J. Bowman (Chicago: Aldine, 1965).

TABLE 4
EFFECTS OF CURRICULAR CONTENT AND EDUCATIONAL EXPANSION ON ECONOMIC GROWTH, 1960–85 (Full Sample)

	Equation		
	(A)	(B)	(C)
Average yearly instructional time (total)		.00010	
Average annual instructional time in each subject area (circa 1960):			
Mathematics			−.00021
Sciences			.00102†
Languages			.00015
Arts/music			.00064
All social studies			−.00001
Moral/religion			.00059
Physical education			−.00027
Prevocational education			−.00042*
Educational enrollment rates:			
Primary education	.0043†	.0043†	.0042†
Secondary education	.0034*	.0036*	.0035*
Control variables:			
Lagged dependent variable	.68†	.68†	.69†
Mining/oil exporters	.08*	.08	.07
Export commodity concentration	−.003†	−.003†	−.003†
Total fertility rate (1965)	.015	.019	.019
Adjusted R^2	.918	.918	.920
Constant	.91	.81	.74
Number of cases	63	63	63

NOTE.—Unstandardized regression coefficients are reported; dependent variable is per capita real gross domestic product 1985.
* Unstandardized regression coefficient is at least 1.5 times its standard error.
† Unstandardized regression coefficient is at least 2.0 times its standard error.

contribute to long-term economic growth. In fact, the direction of the regression coefficient associated with mathematics education is actually negative.

Does this pattern of curricular effects change when a smaller sample of less developed nations is examined? For the most part, no. Table 5 shows that overall hours of instruction continues to be positive but non-significant, the effects of science education and prevocational education are in the same direction and still significant, and mathematics and language education continue to have little or no effect on economic growth. The main difference for less developed countries is, surprisingly, with respect to aesthetic education and physical education. The results indicate that those Third World countries allocating more hours to aesthetic education

TABLE 5
EFFECTS OF CURRICULAR CONTENT AND EDUCATIONAL EXPANSION ON ECONOMIC GROWTH, 1960–85 (Less Developed Countries Only)

	Equation		
	(A)	(B)	(C)
Average annual instructional time (total)		.00006	
Average annual instructional time in each curricular topic at time 1:			
Mathematics			−.00078
Sciences			.00210†
Languages			.00015
Arts/music			.00156*
All social studies			−.00055
Moral/religion			.00083
Physical education			−.00180*
Prevocational education			−.00094†
Educational enrollment rates:			
Primary education	.0043†	.0043†	.0031†
Secondary education	.0058*	.0057*	.0105†
Control variables:			
Lagged dependent variable	.66†	.67†	.66†
Mining/oil exporters	.10*	.10*	.07
Export commodity concentration	−.004†	−.004†	−.003†
Total fertility rate (1965)	.044	.045	.034
Adjusted R^2	.839	.835	.866
Constant	.79	.71	.82
Number of cases	43	43	43

NOTE.—Unstandardized regression coefficients are reported; dependent variable is per capita real gross domestic product 1985.
* Unstandardized regression coefficient is at least 1.5 times its standard error.
† Unstandardized regression coefficient is at least 2.0 times its standard error.

experienced, other things being equal, stronger growth rates; those that allocated more time to physical education experienced slower growth rates.

The reasons for these unexpected relationships are not entirely clear. Greater curricular emphasis on physical education in some less developed countries may reflect the importance of paramilitary training or a well-developed military infrastructure, the consequences of which could be the siphoning off of potentially productive resources from the industrial or manufacturing sectors of the economy. Greater emphasis on art and music education may indicate the cultural effect of Western educational philosophies that have historically placed a premium on this form of childhood socialization at the elementary level. If such systems have been penetrated culturally by the West, then it might be expected that their economies are more open to Western markets and trade arrangements and, thus, more likely to have benefited from Western aid and loans. These patterns, while suggestive, certainly demand further analysis.

The final series of panel models reported in tables 6 and 7 examine the multiplicative (or nonadditive) effects of enrollment expansion and hours of instruction in different subject areas on economic growth. The basic findings from these models tend to reinforce and, to a lesser extent, expand on those reported from the additive models. First, the results show that exposing a larger primary school cohort to more hours of science education produced clear benefits in terms of economic growth between 1960 and 1985. Second, nations with greater proportions of enrolled primary school students who were exposed to more hours of prevocational subject matter experienced, once again, a significant negative economic effect. Third, there was no evidence of an interaction effect

TABLE 6
INTERACTION EFFECTS OF CURRICULAR CONTENT AND EDUCATIONAL EXPANSION ON ECONOMIC GROWTH, 1960–85 (Full Sample)

	Equation		
	(A)	(B)	(C)
Average yearly instructional time (total)		.00020*	
Proportion of school-age cohort exposed to instructional hours in subject area (circa 1960):			
Mathematics			−.00053
Sciences			.00125†
Languages			.00044*
Arts/music			.00031
All social studies			.00022
Moral/religion			.00055
Physical education			−.00024
Prevocational education			−.00040*
Educational enrollment rates:			
Primary education	.0043†	.0027†	.0028*
Secondary education	.0034*	.0037†	.0034†
Control variables:			
Lagged dependent variable	.68†	.67†	.70†
Mining/oil exporters	.08*	.08*	.08*
Export commodity concentration	−.003†	−.003†	−.003†
Total fertility rate (1965)	.015	.021	.020
Adjusted R^2	.918	.920	.920
Constant	.91	.90	.82
Number of cases	63	63	63

NOTE.—Unstandardized regression coefficients are reported; dependent variable is per capita RGDP 1985.
* Unstandardized regression coefficient is at least 1.5 times its standard error.
† Unstandardized regression coefficient is at least 2.0 times its standard error.

TABLE 7
INTERACTION EFFECTS OF CURRICULAR CONTENT AND EDUCATIONAL EXPANSION ON ECONOMIC GROWTH, 1960–85 (Less Developed Country Sample)

	Equation		
	(A)	(B)	(C)
Average yearly instructional time (total)		.00022	
Average annual instructional time in each subject area (circa 1960):			
Mathematics			−.00148
Sciences			.00280†
Languages			.00030
Arts/music			.00191*
All social studies			−.00075
Moral/religion			.00098
Physical education			−.00198
Prevocational education			−.00133†
Educational enrollment rates:			
Primary education	.0043†	.0025	.0030
Secondary education	.0034*	.0054*	.0122*
Control variables:			
Lagged dependent variable	.66†	.68†	.67†
Mining/oil exporters	.10*	.09*	.08
Export commodity concentration	−.004†	−.004†	−.003†
Total fertility rate (1965)	.044	.048	.039
Adjusted R^2	.839	.840	.867
Constant	.79	.71	.73
Number of cases	43	43	43

NOTE.—Unstandardized regression coefficients are reported; dependent variable is per capita real gross domestic product 1985.
* Unstandardized regression coefficient is at least 1.5 times its standard error.
† Unstandardized regression coefficient is at least 2.0 times its standard error.

concerning mathematics education. These three results were obtained in both the full sample of 63 countries and in the smaller sample of 43 less-developed countries. Furthermore, the positive impact of instructional hours devoted to the arts and music in less-developed nations was also apparent in these multiplicative models (see eq. [C] of table 7).

Two additional interaction effects were significant and deserve to be noted. First, in table 6, the model estimated in equation (B) indicates that among nations with high primary enrollment rates, overall instructional time had a positive and significant effect on economic growth. Irrespective of the subjects taught, more class time in expanded mass school systems produced long-term economic benefits. Second, in equation (C) of the same table, there was evidence that annual hours of language instruction in more expanded primary school systems had a positive economic effect.

This interaction effect appears limited, however, to more developed nations: while the effect of language education is positive and significant in table 6, it is positive but nonsignificant in table 7, which looks exclusively at less developed nations.

In summary, most subjects areas of the primary school curriculum, when measured in terms of official annual hours of instruction, were found to be unrelated to long-term changes in national economic production. Two subjects areas, however, were found to have consistent and significant effects on economic growth during the period under examination. Specifically, annual hours of instruction devoted to science education had strong, positive effects in both additive and multiplicative models and in both samples examined. By contrast, annual hours of instruction devoted to prevocational or practical subject matter had strong, negative effects in each of the specified models.[42] Alternative interpretations of this pattern of curricular effects follow.

Discussion

Most educational researchers, if asked to evaluate the relative economic value of different curricular subject areas, would undoubtedly rank mathematics and science education near the top, assuming that the skills, knowledge, and underlying principles imparted by these curricular subjects have the greatest relevancy to a nation's economy and technological potential. Many would also underscore the importance of reading, writing, and communication skills; these are presumed to be basic skills in language education that augment and enhance the productivity of future workers in the labor market. The economic value of prevocational or practical subjects (from farming and gardening to manual training and domestic science) would be seen in a more controversial light. Some would argue that these areas of the curriculum have direct and important spillover effects on local and national economies, especially in the Third World, where primary schooling is the final destination of many students. Others would question their relevance on one of two grounds: the skills and knowledge that are taught in this area become quickly outmoded due to technological advances; or, practical subject matter is perceived (by students, parents, and/or teachers) as marginally important to an essentially academic educational enterprise and, thus, of little value for subsequent occupational attainment. As to the remaining curricular subjects (art, music, history, geography, social studies, religion, moral education, and physical education),

[42] Additional analyses, not reported here, indicate that the positive effect of science education is strong throughout the Third World, especially in some of the poorest and least developed nations of the world. In contrast, it was found that, while prevocational education had negative effects in both poorer and richer less developed countries, they were only significant in the former category of nation-states.

educational scholars might possibly view them as important for the cognitive and moral development of young children or for a country's sense of national identity, cultural cohesiveness, common political purpose, and overall national integration. It is hard to imagine, however, that they would be perceived as directly relevant to a nation's economic prosperity.

The positive effect of science education and the negative effect of prevocational education provide credible evidence especially for both the promoters of science who wish to increase its emphasis in elementary schools and the detractors of vocational education who would substantially reduce its place in the primary curriculum. Such an inference, however, would be a narrow and overly simplistic assessment of the above findings. Several alternative explanations should be considered.

Consider, first, the following argument. It is quite possible that the measure used in the above analyses (annual instructional hours in elementary science) is actually a proxy measure for a related attribute of nations. Many countries that emphasize the teaching of science in elementary schools may also be the same countries that emphasize science education in secondary schools or in postsecondary institutions or the same countries that allocate substantial resources to basic scientific research and development. If the "real" economic effect of science education occurs at a higher level of the national educational system (or outside the educational system altogether), then additional research is necessary before we conclude that X hours of primary science instruction appear to increase national income levels by X dollars each year. In fact, a recent cross-national study (including both more and less developed countries) reported that nations enrolling more tertiary students in the natural sciences and engineering fields (as a percentage of the 20–24 age cohort) in 1960 experienced greater rates of economic growth during the 1970s. The same study also found that, contrary to accepted opinion, indicators of a nation's scientific infrastructure had weak effects on subsequent economic growth.[43] Complementary findings such as these need to be carefully checked before simple inferences are drawn.

If, on additional study, annual hours devoted to elementary science continue to have significant effects, then we should consider a second, less literal interpretation of the effect of science education. What might the content of science education actually signify, especially in the educational context of Third World countries, and what transformative effects might this curricular subject engender for a given set of pupils? Of all the curricular subject areas in the primary curriculum, science education, as usually taught, is most closely associated with a Western, rationalistic,

[43] Francisco Ramirez and Molly Lee, "Education, Science and Development" (paper presented at the annual meeting of the American Sociological Association, Cincinnati, August 1991).

cause-and-effect view of the world. For students growing up in agrarian societies with strong religious traditions and minimal contact with modern medical practices or new technological devices, science education at the elementary level may be their first exposure to such a fundamentally different way of "being in" and viewing the world. If this be the case, then the economic effect of science education may have more to do with "hidden" cultural rules, orientations, and worldviews being transmitted than the specific scientific content being taught. Such an interpretation, while plausible, would be difficult to establish in an exclusively quantitative research design, but it is nonetheless an alternative explanation of positive impact of science education that needs to be investigated.

Conclusion

This study shows that the curricular content of mass schooling, as distinct from school expansion, has an effect on national economic growth, although not for all subject areas usually thought to be economically relevant and not across all types of countries. Countries requiring more hours of elementary science education, other things being equal, experienced more rapid increases in their standards of living during the 1960–85 period. It was not established if the emphasis on science education at the primary level is the key causal factor, or if the explicit (rather than implicit) content of this subject area is the key mechanism linking the curriculum to the economy; these points require further explication.

Future research should also consider that instructional time set aside for mathematics and language education, at least at the primary level, appears unrelated to long-term economic growth. Why this should occur—especially in light of numerous and passionate arguments advanced throughout the world stressing the importance of mass literacy and numeracy as a precondition for economic development—is an unexpected finding that demands further clarification. Equally interesting, in terms of its political and educational ramifications, is the potential importance of aesthetic education (i.e., art, music, dance, drawing) as it relates to the economic growth of certain less developed nations.

While the design, reform, and study of national school curricula are increasingly prominent on the political and scholarly agendas of many nations, received wisdom and commonsense ideas in this area may cloud, rather than clarify, our vision as to the potential economic payoffs of different curricular subject areas. To be sure, the relative economic consequences of different subject areas are certainly not the only deciding standard for emphasis or deemphasis of particular areas of school knowledge, but they provide a backdrop for a more informed discussion among all interested parties, be they parents, local administrators, national and international planners, or educational researchers.

Appendix
Countries in Cross-national Analyses

Less Developed Countries
Afghanistan
Argentina
Bolivia
Chile
China
Colombia
Congo
Costa Rica
Dominican Republic
Egypt
El Salvador
Ethiopia
Ghana
Haiti
Honduras
Hong Kong
Iceland
India
Indonesia
Iran
Iraq
Israel
Jamaica
Jordan
Liberia
Madagascar
Malaysia
Morocco
Nepal
Nicaragua
Pakistan
Panama
Paraguay
South Korea
Sri Lanka
Sudan
Suriname
Tanzania
Thailand
Togo
Tunisia
Turkey
Zimbabwe

More Developed Countries
Australia
Austria
Bulgaria
Canada
Czechoslovakia
Denmark
Finland
France
Greece
Hungary
Ireland
Netherlands
Norway
Romania
Soviet Union
Spain
Sweden
Switzerland
West Germany
Yugoslavia