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Curricular Content, Educational Expansion, and Economic Growth

Aaron Benavot

Many academicians, politicians, and educators strongly believe that knowledge, organized in school curricula and transmitted through school systems, contributes to the economic strength of nations. How valid is this claim?

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This paper — a product of the Education and Employment Division, Population and Human Resources Department — is part of a larger effort in PRE to examine the effects of primary education on development. Copies are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Cynthia Cristobal, room S6-214, extension 33640 (27 pages, with tables).

Benavot examines whether national variations in curricular content and subject area — as distinct from growth in enrollment or qualitative provisions — have a significant impact on economic development.

The study focuses on primary education in 60 nations and assesses the economic impact of an emphasis on eight different primary level subject areas, with special attention to mathematics and science.

Benavot found that the curricular content of mass education is directly related to national economic growth. This relationship, however, is not consistent across all subject areas and all types of countries.

Countries requiring more hours of elementary science education, for example, generally experienced more rapid increases in their standards of living during the periods from 1960 to 1985. Whether science education at the primary level is the key causal factor and whether the explicit content of the subject area is the key mechanism remain unclear.

The design, reform, and study of national school curricula are increasingly visible in political and scholarly agendas. Conventional wisdom on these matters, however, may cloud rather than clarify a vision of the potential economic benefits of different choices of subjects for curricula.

The economic consequences of emphasizing different subject areas should not be the sole criterion for decisionmaking in designing curricula. However, these consequences can provide one useful element for promoting more informed discussion among such interested parties as parents, school administrators, national and international planners, and educational researchers.

Curricular Content, Educational Expansion, and Economic Growth*

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Introduction

National-level studies of education and economic growth have established that mass educational expansion -- mainly at the primary level but, to a lesser extent, at secondary level -- has a significant positive impact on economic growth (Meyer et al., 1979; Wheeler, 1980; Walters, 1981; Benavot, 1989). There is also evidence that "qualitative" features of national school systems (e.g., pupil expenditures, textbook provisions, teacher training) have modest economic effects, especially in the developing world (Heyneman and Siev-White, 1985; Fuller and Heyneman, 1989). Debate currently continues as to specific array of political, social and historical conditions under which the economic impact of mass education is most likely to be pronounced (e.g., Fuller et al., 1986; Hage et al., 1988).

The present study, by contrast, focuses on a new line of inquiry. It explores, from a cross-national perspective, the relationship between official curricular policies and long-term economic growth. Specifically, it seeks to determine whether, and to what degree, national variations in curricular content and structure -- as distinct from enrollment growth or qualitative provisions -- have a significant impact on economic development. Comparative educational research typically analyses the content of national school systems according to a three-tiered classification scheme: the official, intended curriculum; the implemented curriculum; and the achieved curriculum (Garden, 1987). This study exclusively focuses on the economic consequences of the first tier -- the formally proscribed curriculum set forth by national educational authorities -- and only for primary education. Based on a sample of over 60 nations (including 43 less-developed countries), it examines the impact of official emphases in eight different primary-level subject areas (as measured by average annual hours of instruction) on long-term economic growth between 1960 and 1985. Mathematics and science education, two subject areas which many believe to be especially pertinent to the economic prosperity of nations, are highlighted throughout the paper.

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 national policies such as lengthening the school term (e.g., Karweit, 1985) or requiring more instruction in academic as opposed to vocational or "value-oriented" subjects (e.g., religion, moral education, civics). Second, they entail a preliminary test of the widely assumed, though still unsubstantiated, claim that an emphasis on mathematics and science education in elementary or secondary schools is a critical precursor of economic prosperity. Third, they indirectly address an issue of great concern to comparative educational research -- namely, what are the underlining mechanisms through which mass schooling plays such a pivotal role in the social and economic development of Third World nations (Colcough, 1982; Psacharopolous and Woodhall, 1985, Lockheed and Verspoor, 1990)?

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 many academics, politicians and educators. Especially in the 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 play a role in international economic competition (Goodson, 1983; Popkewitz, 1987; Kleibard, 1987; Hage et al., 1988; Cha, 1989). Many believed then that an economically relevant school curriculum emphasizing scientific reasoning, mathematical skills, modern language proficiency and technical knowledge (rather than high status instruction in classical languages and literature) was needed in order to ensure a productive work force and a dynamic industrial economy.

Similar beliefs are voiced today. Recent calls to reform national curricular policies are often tied to concerns over a nation's competitiveness in the world economy -- or the lack thereof (Nation at Risk, 1983). Consider the following typical argument with reference to the U.S. and Japan which is especially salient in the popular press and in 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 which spills over into the workplace; they are exposed to more academic subjects, especially mathematics and science, which facilitates higher order cognitive development among pupils as well as technological innovation and economic competitiveness. The decline of educational excellence in the United States, so the argument goes, mirrors its declining share of international markets, its diminishing capacity for manufacturing high quality goods and its rising trade deficits. If educational 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 reaffirm its competitive edge in the world economy (among many such citations, see those discussed in Gross and Gross, 1985; Doyle and Levine, 1985).

In addition, studies of cross-national variations in educational achievement have often been used to partially explain past economic growth rates or foreshadow future ones. The findings from two major comparative research projects are particularly relevant in this regard. The first involves the well-publicized findings of recent IEA studies of academic achievement in the areas of mathematics and science (McKnight et al., 1987; Rosier, 1987; IEA, 1988; Travers and Westbury, 1989); the second relates to the cross-cultural research of H. Stevenson and J. Stigler comparing the academic achievement of Japanese, Chinese and U.S. elementary students (Stigler, Lee, Lucker and Stevenson, 1982; Stevenson, Lee and Stigler, 1986). These two projects, taken together, tend to show average or below average scores of U.S. and some Western European pupils but significantly higher achievements among Japanese and other Asian students on standardized mathematics and science tests.

Based on the (mostly) cross-sectional analyses performed in these studies, researchers have concluded that national variations in academic achievement are very much related to the organization and structure of the national school curriculum. In addition, the basic descriptive findings of these studies have lent support to rhetorical arguments tying national curricular content to economic performance. Thus, without any solid empirical support, it has become received wisdom that the composition and structure of national curricula, by their influence on student achievement levels, have important effects on the quality and productivity of work force and, in the long run, on a nation's competitive position in the world economy.

How valid and logically consistent are such claims? To begin, 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 U.S. (240 days versus 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 (Kobayashi, 1984). (This is not necessarily true for each subject area at each level of the educational system). Greater levels of overall instructional time, both in-school and extra-school, are certainly a factor in the superior performance of Japanese pupils on mathematics and science tests and, presumably, they have contributed to the rapid expansion of the Japanese economy in recent decades, 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 emphasis of effort over innate ability and so on -- differences that may account for subsequent educational and economic performance (Shimahara, 1985; U.S. Department of Education, 1987). Second, when a larger sample of countries is examined, 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 (McKnight et al., 1987).

Third, and perhaps most significantly, 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 (see Meyer, 1977). Furthermore, 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 upon 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 knowledge they may have actually gained through schooling (Collins, 1979).

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 productivity. For example, by increasing students' interests in university-level programs in science, engineering or technology, or by influencing student attitudes towards and underlying public support for government investment policies in science and technology, on the one hand, or basic research and development on the other, features of the school curriculum could have long-term development effects in a context of relatively low achievement levels. In short, there is a dearth of well-designed comparative studies which directly address the issue of whether variations in national curricular policies, independent of student achievement levels, have significant, aggregate-level impacts on macroeconomic change.

Curricular Policy Reforms in Less-Developed Nations

While arguments concerning the economic impact of school curricula have been intensely debated and discussed in advanced, industrialized nations, they have special relevance in the context of the developing world. The school curricula of newly independent nations, which were largely shaped by the interests of former colonial powers and missionary authorities, have been re-assessed -- and often restructured -- in light of a diverse array of new purposes: forging national unity, training highly skilled manpower, spreading literacy throughout the population and promoting "modern" values and ideas. Although many developing countries made only minor changes to the previously used school curricula or simply imported new curricular materials from the metropolitan centers, others undertook significant curricular reforms to re-organize the content of mass education. The push to integrate "modern" school subjects with scientific and mathematical content alongside older subject emphases such as religion, language and practical training was especially pronounced. During the post-World War II era, for example, virtually all developing countries mandated some form of mathematics and science instruction in public elementary schools (Kamens and Benavot, forthcoming). And at the lower secondary level (grades 7-9), these two subject areas have become ubiquitous, core elements in the school curricula of developing countries, taking up close to 40 percent of total instructional time (UNESCO, 1986).

Table 1 presents detailed longitudinal evidence concerning the growing importance of mathematics and science education in the official school curricula of less-developed countries. In the area of mathematics, the top sections of table 1 show that the relative emphasis on and the average amount of instructional time devoted to this subject at the primary level increased in all developing regions between 1960 and 1980. Curricular time allocated to science education also increased, 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. If anything, less-developed nations placed greater curricular emphasis on elementary science than more-developed OECD nations. Interregional variations at the primary level are apparent, but relatively small: mathematics and science education were given somewhat more emphasis in Latin America and the Caribbean 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).

The main point of this table is that nations around the world, especially in the Third World, have substantially increased required instructional time in mathematics and the sciences, the two subject areas thought to have the greatest economic and technological relevance, even though there is little conclusive scientific evidence confirming the long-term economic impact of these subjects. Two ideas -- one, that it is necessary to expose young people to the basic principles of modern science (the world is empirical and lawful and governed by natural forces) and, two, that the application of scientific knowledge through technology will improve the quality of life of individuals and contribute to community, national and economic development (UNESCO, 1984) -- have apparently become abiding articles of faith in the modern world .

These cherished beliefs -- and the more general thesis that the content of schooling directly contributes to a range of societal outcomes such as economic growth or scientific productivity -- have never, as previously noted, been empirically tested. In the next sections initial results from such a test are described and reported. 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. In addition they examine whether the economic impact of different school subjects varies among more- and less-developed countries.

Data Sources

Most of the 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. The main dependent variable, economic growth, was measured by per capita real gross domestic product (RGDP) in constant 1980 international prices (Kravis, Heston and Summers, 1982; Summers and Heston, 1988).[1] This variable, in contrast to the more widely-used measure gross national product (GNP), provides more realistic and comparable estimates of national income levels and purchasing power parities. Since the distribution of per capita RGDP data 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 which refer to annual instructional hours in different curricular subjects (to be discussed below), several other independent and control measures were incorporated into the analyses. 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 (UNESCO, 1970). In addition, three other control measures were included since previous cross-national studies have shown them to have significantly effects on economic growth rates. These include: 1) population growth: this was measured by each nation's total fertility rate (UN, 1986) and was expected to have negative effects on economic development; 2) export commodity concentration: this indicator measured one aspect of economic dependence and was expected to negatively affect economic growth (World Bank, 1983); and 3) a "dummy" variable for nations whose economies are highly dependent on oil and mineral exporting, which was thought to have a positive effect on economic growth.

Data on national curricular structure and content came from a wide array of published and unpublished sources. A considerable amount of curricular information was gathered from reports of international agencies such as UNESCO, comparative educational handbooks and encyclopedia, historical surveys of national and colonial educational systems, contemporary case studies of educational developments in particular countries, and two sets of microfiche from the International

1. Similiar results were obtained, though for a slightly smaller sample, when per capita GNP was employed as the dependent variable.

Bureau of Education (IBE, 1984; 1986). Data on school curricula was also coded from official correspondence and national publications that were received directly by a team of researchers of which the author was a member. Of the over 150 national ministries of education to which short questionaires were sent in 1985, approximately half 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 (Benavot and Kamens, 1989; Kamens and Benavot, forthcoming).

Two basic pieces of information were coded from these sources: first, a list of the subjects taught during the elementary school cycle in each country; and second, the number of school periods or school "hours" devoted to each subject during the primary school cycle.[2] This coding procedure produced two types of variables for each subject: first, a dichotomous variable which simply noted whether or not a particular subject was taught in the official curriculum; and second, a continuous interval variable indicating the proportion of total school periods or "school hours" that each subject was taught during the first six years of primary education. Data on these variables were then grouped according to historical period (e.g., 1945-1969; 1970-1986) 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. Instead of measuring the relative emphasis of each subject in the national curriculum (i.e., the proportion of total curricular periods devoted to mathematics or science education), it estimated the actual amount of time (in annual hours) that pupils were exposed to instruction in each subject area during each year of the primary school cycle. Recent reports (e.g., McKnight et al., 1987: 53; UNESCO, 1986) as well as past ones (e.g., Dottrens, 1962)

2. 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 Pre-Vocational 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) were 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.

suggest that cross-national variation in annual instructional time is quite marked. Thus, for example, while the relative emphasis on mathematics or science in the official primary curriculum may change slowly over time or vary quite modestly over national space, measures of the number of hours mathematics and science subjects are taught each year are thought to vary more markedly. Also, many scholars maintain that students learn more when they are exposed to more instruction in a particular subject area or when they spend more time "on task" (Fisher and Berliner, 1985; Karweit, 1985; Murphy and Hallinger, 1989). One might then draw the following two inferences: 1) nations gain more, in economic or political terms, when their mass school systems require more overall time of formal instruction; and 2) nations gain more when they expose greater 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 ideas will be tested in this study.

To develop estimates of annual instructional time, published sources and official correspondence were examined so as to retrieve 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 supposed 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 this sort of data, there is good reason to believe that they permit reasonably valid and reliable comparisons across national space (for further discussion of how these figures were estimated, see Kamens and Benavot, forthcoming).

The Meaning of Official Curricular Data

The curricular data employed in this study are official policy declarations of subjects to be taught in primary schools, generally produced by government education officials in the form of national timetables and syllabi. It is clear that official statements of curricular policy can be -- and many times are -- poorly related to local educational 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 (Weick, 1976; Meyer and Rowan, 1977; Baker and Stevenson, 1989) and is assumed to be even greater in the newly established educational systems of developing nations (Hawes, 1979; Lockheed and Verspoor, 1990).

If the gap between educational rules and classroom reality is so pronounced, why study the effects of official curricular rules? First, and most obviously, official statements 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. National differences in official time allotments to particular subject areas reflect genuine differences in subject emphases and educational philosophies. Second, under certain conditions, official curricular policies may closely approximate the actual content of local schools. For example, when there is strong 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 (see Baker and Stevenson, 1989), the gap between the official and implemented curriculum may be relatively small.

But do official data obscure more than they reveal? If official policies concerning the curriculum are simply ideological statements intentionally developed by national educational leaders to reflect the "proper" educational standards of international donor agencies (who make critical decisions regarding educational loans and grants), then our 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 historical research suggests that there was considerable similarity (convergence) in official curricular policies <u>prior</u> to the establishment of international educational and development agencies such as UNESCO, IBE and the World Bank (Benavot et al., 1988; Kamens and Benavot, 1990).

However, official curricular policies among contemporary nation-states are more than superficial reflections of curricular standards imposed by external agencies. There is growing evidence that the curricular policies articulated by national educational leaders are both reflective of and influenced by an emerging global educational culture (see Meyer, Benavot and Kamens, forthcoming). At the very least, it is interesting to examine whether national standards of curricular policy have long-term effects on important societal changes such as economic growth, and we shall turn to this issue presently.

Research Design and Methodology

This quantitative cross-national study attempts to establish causal relations between variable features of social units (in this case, nations) using a non-experimental research design. The defining feature of this type of comparative research is its use of attributes of macrosocial units in the explanatory statements (Ragin, 1987). As in previous cross-national analyses of economic growth, this study uses aggregate, national level data. The unit of analysis is 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, the advantages of which have been discussed by Hannan (1979) and Tuma and Hannan (1984). Panel regression analyses incorporate both variation between nation-states and variation over time. They basically involve regressing the dependent variable at a latter time point (t2) on the same variable measured at an earlier time point (t1) and on a series of independent variables also measured at the earlier time point (t1). In the present study, a 25-year panel design was used in which the level of economic development at 1985 was 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.[3]

Analyses were performed separately for all nations and for a smaller sample of only developing nations in the Third World 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

3. A shorter panel design in which fifteen year lagged effects were examined produced results that are nearly identical to those reported in the paper.

different world regions, except sub-Saharan Africa, is fairly representative. Appendix A lists the specific countries included in the analyses.

Analyses and Findings

This section presents results from cross-national analyses of curricular subject areas and their effects on economic growth. It begins by briefly surveying descriptive statistics concerning the main explanatory variables used in the panel regression models. Table 2 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 higher among developed countries (917.0 hours per year) than among developing countries (849.3 hours per year). Furthermore, the three R's tended to take up about half of all instructional hours: reading and writing (i.e., language education) was allocated over 300 hours of instruction; arithmetic and other math-related subjects about 145 hours of instruction. The remaining instructional time was distributed among a series of "core" subjects which were required in almost all national primary curricula and a set of more "peripheral" subjects which were required in less than three-fourths of all countries (see Benavot et al., 19[illegible]). Core subjects included art and music (81.2 hours per year), social sciences (75.6 hrs./year), natural sciences (63.3 hrs./year), and physical education (58.7 hrs./year). Peripheral subjects included religion and moral education (50.5 hrs./year) and pre-vocational education (65.4 hrs./year). Differences in average time allocations by level of development were minimal in science education and religious and moral education, as well as in the combined area of history, geography and social studies. In the remaining subject areas, developed nations placed greater emphasis on aesthetic education and physical education and less emphasis on pre-vocational education than developing nations in the Third World.

Table 3 presents zero-order correlations among all the variables used in the panel regression analyses. By and large, correlations between most curricular emphases and levels of economic development are weak and non-significant. Two subject areas, mathematics and physical education, have positive, but not especially strong, associations with economic development; pre-vocational education and economic development are negatively correlated. As expected, associations between the other independent variables (rates of educational expansion, fertility rates, export commodity concentration) and economic development are strong and in the expected direction. Although table 3 reports several instances of relatively high correlations among independent variables, which could potentially be a source of multicollinearity (Hanushek, 1979), these were later checked using a series of regression diagnostics (Belsey, Kuh and Welsch, 1980) and found to have no adverse impact on the main pattern of results reported below.

In the panel regression analyses, three different models were estimated. In the first model, a baseline equation was estimated 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 aforementioned control variables. The second model added to this baseline equation a single measure for overall yearly instructional time at the primary level (that is, across all subject areas). The third model estimated the economic effects of the more detailed measures of annual instructional time in eight different subject areas (mathematics, science, language, art/music, social science, religion/moral education, physical education and pre-vocational education) after controlling for the influence of educational expansion, fertility rates, high income oil exporters and commodity concentration. These three models were first estimated for the full sample of countries (table 4) and then for a smaller sample of less-developed countries (table 5). In all 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 economic impact of interaction effects between curricular time allotments and the level of educational expansion at the primary level were also analysed (see tables 6 and 7). Such interaction (or multiplicative) effects measure what percentage of students in each nation were exposed to how many hours of formal instruction in each subject area and were constructed by multiplying the primary enrollment rate by the annual hours of instruction in each subject area. These indicators are analogous to measures of the "yield" or "productivity" of an educational system which have been employed recently in the IEA studies of mathematics achievement (McKnight et al., 1987: 61).

The baseline model estimated in table 4 (equation A) shows that educational expansion at both the primary and secondary levels has a significant positive impact on economic growth between 1960 and 1985. This finding confirms the results of earlier cross-national studies (Meyer et al, 1979; Benavot, 1989). 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 insignificant but, in contrast to previous cross-national studies of economic growth, the coefficient is positive. This may be due to the particular sample of countries included or, more likely, to the historical period under examination.

Table 4 also reports that the effect of overall annual hours of instruction across all subject areas is positive but not significant (equation B). When this measure is broken down by subject area (equation C), two of the eight subject areas have significant effects on economic growth: science education (a positive effect) and pre-vocational or practical education (a negative effect). Interestingly, there is no evidence that instructional hours devoted to elementary mathematics have a significant impact on economic growth -- indeed, the direction of the regression coefficient associated with mathematics education is 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, that the effects of science education and pre-vocational education are in the same direction and still significant, and that mathematics education continues to have little or no impact on economic growth. The main difference for less-developed countries is, surprisingly, with respect to aesthetic education and physical education. The results reported in equation C of table 5 indicate that Third World countries which taught more hours of art and music education experienced, other things being equal, stronger growth rates; those that devoted more time to physical education experienced weaker growth rates.

The reasoning behind these unexpected relationships is not entirely clear. Greater emphasis on physical education in some countries may reflect a form of paramilitary training and a well-developed military infrastructure which, in the long run, may drain potentially productive resources from the overall economy. Greater emphasis on art and music education may indicate the cultural impact of Western educational conceptions and philosophies which have historically placed a premium on this form of child socialization at the elementary level. If such systems have been penetrated culturally by the West, then their economies may also be oriented to Western market arrangements and thus more likely to have been targets of international economic aid and loans.

These patterns, while suggestive, certainly demand further analysis.

The final series of panel models examine the multiplicative (or non-additive) effects of enrollment expansion and hours of instruction in different subject areas on economic growth (see tables 6 and 7). 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 indicate 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 practical or vocational subject matter experienced, as noted earlier, a significant negative economic impact. Third, there was no evidence of any interaction effect of mathematics education. This three results 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 hors devoted to arts and music in less-developed nations was also apparent in these multiplicative models (see equation 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 ratres, overall instructional time had a positive and significant impact on economic growth. Irrespective of the subjects taught, more class time in expanded mass school systems produced long-term economic effects. Second, in equation C of the same table, there was, for the first time, evidence that annual hours of language instruction in more expanded primary school systems had a positive economic impact. This interaction effect appears limited, however, to First World nations: while the effect of language education is positive and significant in table 6, it is positive, but non-significant in table 7 which exclusively looked at less-developed nations.

Overall, these results indicate that most subjects areas of the primary school curriculum -- at least when measured in terms of official annual hours of instruction -- are 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: annual hours of instruction devoted to science education had strong, positive effects in both additive and multiplicative models as well as in both of the samples examined. By contrast, annual hours of instruction devoted to pre-vocational subject matter (farming, manual training, agriculture, domestic science, etc.) had strong, negative effects in each of the specified models.[4] Possible explanations for this pattern of effects will be discussed in the final section of the paper.

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 productive potential. Many would also underscore the basic importance of reading, writing and communication skills (for future workers in the labor market) which presumably are taught and stressed in the area of language education. The economic value of pre-vocational or practical subject matter (from manual training to farming and domestic science) would probably be seen in a more controversial light: some would argue that such areas of the curriculum have direct spillover effects for local and national economies, especially in the Third World where primary education in the final destimation of most students; others would question their relevance since much of what is taught may become quickly outmoded due to technological changes or since this subject area is viewed by many students, parents and teachers as marginally important to the overall educational enterprise and to subsequent occupational attainment. The remaining curricular subjects (i.e., art, music, history, geography, social studies, religion, moral education, and physical education), while possibly 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, would not be viewed as directly relevant to national economic prosperity.

The positive impact of science education and the negative impact of pre-vocational apparently provide credible evidence for the promoters of science, especially those who would increase its emphasis in elementary schools, and the detractions of vocational education who would reduce

4. Additional analyses, not reported here, indicate that the positive impact of science education is strong throughout the Third World, especially so in some of the poorest and least developed nations of the world. On the other hand, it was found that while pre-vocational education had negative effects in both poorer and richer LDCs, they were only significant in the first category of nation-states.

substantially its place in the primary curriculum. Such an inference, however, would be a narrow and overly simplistic reading of the findings. Several alternative explanations can be advanced (and, indeed, need to be tested).

For example, it is quite possible that the measure, annual instructional hours in elementary science, is actually a proxy variable for national emphasis on science education in secondary schools or university institutions or for basic national commitments to scientific research and development. Whether the "real" economic impact of science education is to be located at another level of national educational systems, rather than at the elementary level, needs to be explored systematically by employing controls for national emphases on science education and scientific research and development.

Another potential explanation, especially in relation to the developing world, concerns what the content of science education may actually signify and what transformative role this curricular subject may entail for the pupils who are exposed to it. Of all the curricular subject areas in the primary curriculum, science education is most closely associated with a Western, rationalistic, cause-and-effect view of the world. For students growing up in agrarian economies and strong religious traditions and with minimal contact to modern medical practices and new technological devices, science education at the elementary level may be their first exposure to a fundamentally different view of the world. If such be the case, then the economic impact of science education may have more to do with the "hidden" cultural rules and orientations being transmitted, rather than the specific formal scientific content being taught. Such an interpretation, while plausible, would be difficult to establish within an exclusively quantitative research design.

In sum, this paper has established that the curricular content of mass schooling, as distinct from its quantitative expansion, is related to 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 1960-1985 period. Whether the emphasis on science education at the primary level is the key causal factor and whether the explicit (rather than implicit) content of this subject area is the key mechanism at work was not established and demands further exploration.

Future research should also cast a potentially critical eye on the fact that mathematics and language education, at least at the primary level, appears little related to long-term economic growth. Why this should occur, given the numerous vocal and passionate arguments advanced throughout the world for the expansion of reading, writing and computation skills (i.e., literacy and numeracy) among the mass population as an important precondition for international competitiveness and economic development, is a surprising result emerging from this study. Equally interesting, in terms of its political and educational ramifications, is the potential importance of aesthetic education (i.e., art, music, dance, drawing) for the economic expansion of certain less-developed nations.

While the design, reform, and study of national school curricula are increasingly visible in both political and scholarly agendas, received wisdom and common sense ideas in this area may cloud, rather than clarify, our vision as to the potential economic payoffs of different curricular subject areas. The relative economic consequences of different subject areas are certainly not the only standard for deciding whether to emphasize or de-emphasize particular areas of curricular knowledge, but they can provide a backdrop for a more informed discussion among all interested parties: parents, local adminstrators, national and international planners, and educational researchers.

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Table 1:
Curricular Emphases on Mathematics and Science Education at the Primary and Lower Secondary Levels, 1960s - 1980s, by World Region (constant cases) 1

A. Proportion of the Official Primary Curriculum Devoted to Mathematics and Science Education

	Latin America/ Caribbean	Asia	Sub-Saharan Africa	Middle East/ North Africa	OECD Countries2	Totals
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

	Latin America/ Caribbean	Asia	Sub-Saharan Africa	Middle East/ North Africa	OECD Countries2	Totals
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)

	Latin America/ Caribbean	Asia	Sub-Saharan Africa	Middle East/ North Africa	OECD Countries2	Totals
Mathematics						
Percent3	14.5 (17)	14.9 (10)	16.5 (18)	13.5 (17)	14.0 (16)	14.7 (78)
Weekly Hrs4	12.5 (19)	12.1 (10)	13.3 (19)	11.5 (17)	11.8 (17)	12.3 (82)
Sciences						
Percent3	17.0 (17)	17.8 (11)	14.6 (18)	13.3 (16)	16.7 (16)	15.7 (78)
Weekly Hrs4	13.6 (18)	14.2 (11)	11.7 (19)	11.1 (17)	14.0 (17)	12.8 (82)

1. Unweighted averages, number of cases in parentheses
2. This category includes Western Europe, North America, Australia and New Zealand.
3. This row refers to the percentage of the official lower secondary curriculum devoted to each subject
4. This row refers to the average <u>weekly</u> hours of instruction at the lower secondary level in each subject

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	S.D.	Mean	S.D.	Mean	S.D.
Log of per capita RGDP 1985	3.40	.46	3.89	.15	3.18	.37
Log of per capita RGDP 1975	3.35	.42	3.80	.15	3.13	.34
Log of per capita RGDP 1960	3.15	.38	3.56	.20	2.96	.29
Mean Yearly Instructional Hours (circa 1960) in:						
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, Geog., 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
Pre-Vocational, 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

Table 43: Correlation Matrix of Variables Used in Panel Regression Analyses[a]
(Sample of Developed countries avoce the diagonal; sample of LDC's below the diagonal)

	(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. Lang. 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 Sci. Instr. Hours	.08	.13	.02	.20	**.53**	**.27**	**.46**	-.16	.20		.12	-.14	**.24**	.02	.00	.09
11. Physical Ed. Instr. Hours	.18	.14	.11	**.31**	**.38**	.22	.22	-.07	**.44**	.16		.03	.06	**-.28**	.02	**-.25**
12. Moral/Rel. Instr. Hours	.05	.04	-.15	.10	.05	-.06	-.13	.07	**-.40**	-.21	.12		.01	.08	-.07	-.02
13. Vocational Instr. 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**	

a) Zero-order correlations in **bold** are significant at least at the .05 level.

Table 4
Effects of Curricular Content and Educational Expansion on Economic Growth, 1960-1985 (Full sample)

(Unstandardized regression coefficients are reported; dependent variable is per capita RGDP 1985)

	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 Ed.			-.00027
	Pre-Vocational Ed.			-.00042*
Educational Enrollment Rates:	Primary Education	.0043**	.0043**	.0042**
	Secondary Education	.0034*	.0036*	.0035*
Control Variables:	Lagged Dependent Var.	.68**	.68**	.69**
	Mining/Oil Exporters	.08*	.08	.07
	Export Commod. 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

* 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 5:
Effects of Educational Expansion and Curricular Content on Economic Growth, 1960-1985 (Less-developed countries only)

(Unstandardized regression coefficients are reported; dependent variable is per capita RGDP 1985)

	Equation:	(A)	(B)	(C)
	Aver. Ann. Instruct. Time (Total)		.00006	
Average	Mathematics			-.00078
Annual	Science			.00210**
Instructional	Language			.00015
Time in	Arts/Music			.00156*
Each	All Social Studies			-.00055
Curricular	Moral/Religion			.00083
Topic	Physical Ed.			-.00180*
At Time 1:	Pre-Vocational Ed.			-.00094**
Educational Enrollment	Primary Education	.0043**	.0043**	.0031**
Rates:	Secondary Education	.0058*	.0057*	.0105**
Control	Lagged Dependent Var.	.66**	.67**	.66**
Variables:	Mining/Oil Exporters	.10*	.10*	.07
	Export Commod. 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

* 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 6
Interaction Effects of Curricular Content and Educational Expansion on Economic Growth, 1960-1985 (Full sample)

(Unstandardized regression coefficients are reported; dependent variable is per capita RGDP 1985)

	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 Ed.			-.00024
	Pre-Vocational Ed.			-.00040*
Educational Enrollment Rates:	Primary Education	.0043**	.0027**	.0028*
	Secondary Education	.0034*	.0037**	.0034**
Control Variables:	Lagged Dependent Var.	.68**	.67**	.70**
	Mining/Oil Exporters	.08*	.08*	.08*
	Export Commod. 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

* 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, 1960-1985 (Less-developed country sample)

(Unstandardized regression coefficients are reported; dependent variable is per capita RGDP 1985)

	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 Ed.			-.00198
	Pre-Vocational Ed.			-.00133***
Educational Enrollment Rates:	Primary Education	.0043**	.0025	.0030
	Secondary Education	.0034*	.0054**	.0122**
Control Variables:	Lagged Dependent Var.	.66**	.68**	.67**
	Mining/Oil Exporters	.10*	.09*	.08
	Export Commod. 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

* Unstandardized regression coefficient is at least 1.5 times its standard error
** Unstandardized regression coefficient is at least 2.0 times its standard error

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