DOCUMENT RESUME

ED 292 670 SE 049 039

AUTHOR	Natsoulas, Anthula
TITLE	Mathematics Curricula and Age Cohort Participation: A Six Nation Comparison.
PUB DATE	87
NOTE	26p.; Paper presented at the Annual Meeting of the Mid-Western Educational Research Association (Chicago, IL, October, 1987).
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Comparative Education; *Cross Cultural Studies; Educational Research; *Foreign Countries; *Mathematics Achievement; *Mathematics Curriculum; Mathematics Education; Mathematics Instruction; National Programs; School Holding Power; Secondary Education; *Secondary School Mathematics; Sex Differences; Student Attrition

ABSTRACT

Secondary level mathematics programs of England, Finland, France, Israel, Japan and Swaziland are compared using data from the Second International Mathematics Study and United Nations sources. Within a clearly defined school structure, the number of mathematics course options, age cohort enrollments and male/female ratios are considered with an emphasis on the entry and terminal levels of secondary schooling and details of the mathematics content of the prescribed curriculm of the first year. The results show that most countries have a large proportion of their students in school and generally taking the same mathematics course during the first year of secondary school. By the terminal year, however, the number of mathematics options has increased in all countries while the proportional number of students enrolled in such courses has decreased with equal proportions of males and females in only two of the six countries studied. (Author)

Mathematics Curricula and Age Cohort Participation: A Six Nation Comparison

Anthula Natsoulas
University of Toledo

Paper presented at the annual meeting of the Mid-Western Educational Research Association, Chicago, IL
October, 1987

MATHEMATICS CURRICULA AND AGE COHORT PARTICIPATION: A SIX NATION COMPARISON

ABSTRACT

Secondary level mathematics program of England, Finland, France, Israel, Japan and Swaziland are compared using data from the Second International Mathematics Study and United Nations sources. Within a clearly defined school structure, the number of mathematics course options, age cohort enrollments and male/female ratios are considered with an emphasis on the entry and terminal levels of secondary schooling and details of the mathematics content of the prescribed curriculum of the first year. The results show that most countries have a large proportion of their students in school and generally taking the same mathematics course during the first year of secondary school. By the terminal year, however, the number of mathematics options has increased in all countries while the proportional number of students enrolled in such courses has decreased with equal proportions of males and females in only two of the six countries studied.

The study of mathematics is deemed a necessary part of an individual's education in almost every corner of the globe. The subject matter of mathematics is unique in that its signs and symbols are universal and that it may be regarded as the study of the interrelationships of abstract forms and structures which do not exist in the physical world. Because of this universality we expect and do find many similarities in the mathematics curriculum of different nations. This is not true, however, of mathematics achievement; international studies of achievement in mathematics have shown distinct differences in attainment scores among students from different countries (Crosswhite, 1984, Crosswhite, Dossey, Swafford, McKnight and Cooney, 1985; Husen, 1967).

The purpose of the current study is to consider the nationally defined mathematics curriculm of six countries: England and Wales, Finland, France, Israel, Japan, and Swaziland. The focus is on the construction of a model whereby cross-national comparisons may be facilitated. Within the context of the model two aspects of mathematics study will are investigated:

1. The construct of mathematics offerings within the context of the structure of schooling with emphasis at the entry and terminal levels of secondary education.

2. Student characteristics with respect to proportion of age cohort enrolled and male/female ratios of those enrolled in mathematics courses at the entry and terminal levels of secondary schooling.

Two primary data sources are consulted and integrated in the formulation of the comparisons. National statistical abstracts and United Nations statistical information are used to determine age and school cohort populations. In addition, data from the Second International Mathematics Study is used to determine the nationally defined mathematics curriculum as well as the numbers of participating students at the various levels. Such information is interpolated from participating nation responses to a common questionnaire regarding the nature of mathematics offerings in schools and the numbers of students enrolled in such courses.

In the past three decades the movement in Western Europe has been towards comprehensive schooling in an attempt to make education accessible to all children regardless of sex or social or geographic background with developing countries moving in a similar direction although at a slower pace (Lundgren, 1977; Van de Blij, 1980). An integral part of secondary schooling, the study of mathematics continues to be viewed as elitist in most nations but also as a " gateway" to future educational and career opportunities especially in the context of the increasing technological demands of society (Damerow and Westbury, 1985). The technological progress a particular nation makes depends upon the young people available for scientific careers. And the number of young people available for such careers depends upon their training at the secondary and university levels.

As is true of any discipline, the teaching and learning of mathematics are influenced by a large number of factors. There is no doubt that the curriculum as interpreted by the individual classroom teacher and the resulting opportunity to learn which is afforded to students have a profound effect on student achievement (McKnight, 1980). Classroom activities, however, are molded by factors beyond the teacher's control and it is in this sense that curricular frames and forces can be conceived to contribute to levels of mathematical learning. (International Mathematics Curriculum, Chapter 9, 1984). Such curricular constraints may include: (1) curriculum content options, (2) decisions which are outside the teacher's and student's control and (3) those factors which are determined outside the teaching processes (Lundgren, 1977). It is in this context that the conceptualization of the curriculum at the national level can be said to provide an important framework for classroom implementation.

The mathematics curriculum of any nation fits into the broader framework of grade levels and corresponding age levels, divisions between primary and secondary schooling, and the line of compulsory attendance. It is necessarily affected by the presence or absence of an official national curriculum and by the goals of schooling appropriate to a particular culture. Furthermore, course options should be viewed within the context of how many and which students are taking them.

In the present study three categories of variables are considered: school structure characteristics, mathematics course options, and age cohort participation and student characteristics. School structure characteristics will refer to (1) the correspondence among year of schooling, grade and age levels, (2) the internal divisions of primary and secondary levels of schooling, (3) the level of compulsory education. Course options will (1) delineate mathematics courses available at the levels of secondary schooling with special attention to those at the entry and terminal levels and (2) proportion of instructional time allotted for each course. Cohort participation and student characteristics will specify (1) proportion of age cohort enrolled at each level of schooling, (2) proportion of age cohort enrolled in each mathematics offering, (3) male/female ratios of students enrolled in mathematics courses.

The Second International Mathematics Study compared the international mathematics curriculum at three levels: the intended, the implemented and the attained curriculums and included two student population levels. The first student level, student population A, was equivalent to the eighth grade of schooling in the United States and the seventh grade in Japan. Population B was comprised of those students in the terminal level of secondary schooling who included the study of mathematics as a substantial part (approximately five hours per week) of their academic program (Travers, 1985).

The cultural, economic and political matrix of a nation uniquely determines its character and contributes to the nature of its schooling. Of the six nations chosen for the current study, four, England, Finland, France and Japan are industrialized nations; Israel is middle income and Swaziland is a developing nation. Linguistically, five of the six, England, Finland, France, Japan and Swaziland are unilingual although England, France and Swaziland report minority groups whose mother tongue is different from the national language at 3.3, 8 and 2.4 percent of the population respectively. Israel includes both Hebrew and Arabic speaking populations; only the Hebrew medium schools, however, are considered in this study. The schools in all six countries are therefore unilingual medium schools. With respect to the level of curricular decision making regarding content, all except England have national curriculums. Curricular decision making regarding content is at the national level for Finland, France, Israel, and Swaziland and at the school level for England. Comparable decision making regarding standards is at the national level for England, Finland, France, Japan, and Swaziland with provisions for less able students made at the school level in England, Finland and Japan; in Israel such decisions are made at both the school and national levels. (International Mathematics Curriculum, Chapter 5, 1984)

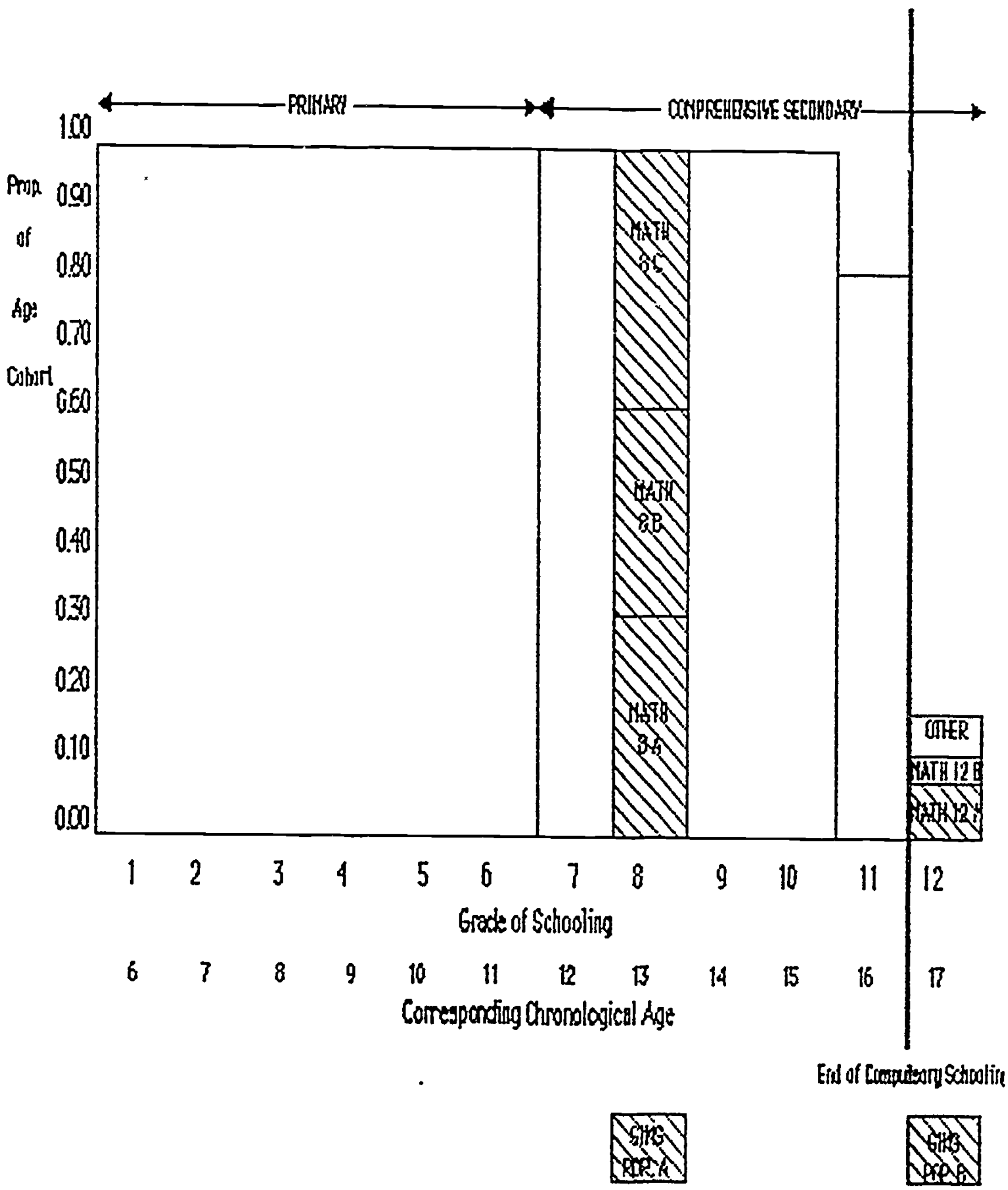
School structure characteristics, mathematics course options and age cohort participation as defined in the above discussion are outlined in Figures 1 to 6 for England and Wales, Finland, France, Israel, Japan, and Swaziland.

Figure 1

School Structure and Mathematics Offerings

by Proportion of Age Cohort

England and Wales[1]



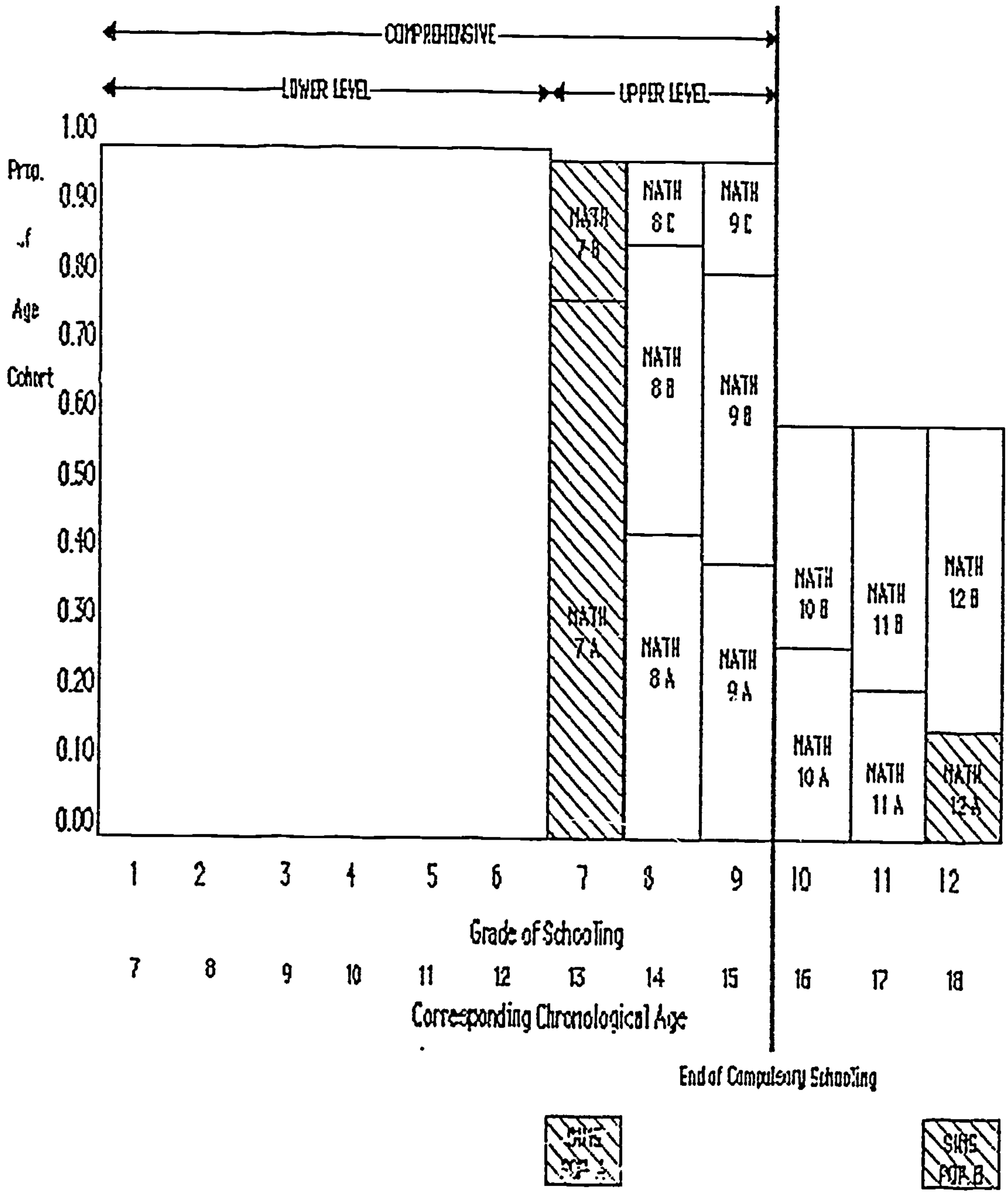
[1]Dept. of International Economic and Social Affairs, 1983; Europa Yearbook, 1985; Torsten and Postlethwaite, Vol. 9, 1985; Working Paper I: England and Wales, 1981-1982.

Figure 2

School Structure and Mathematics Offerings

by Proportion of Age Cohort

Finland[1]



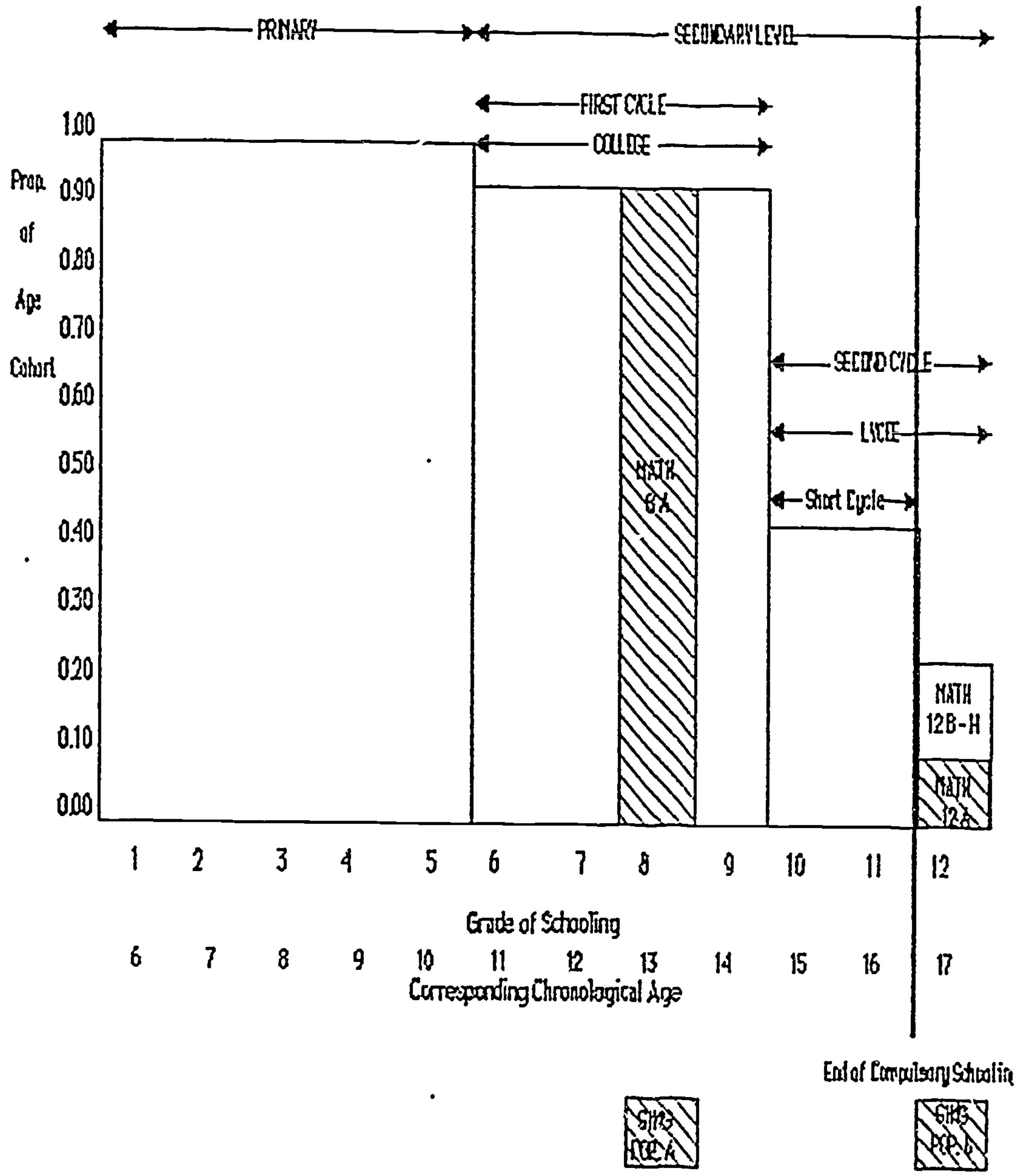
[1]Dept. of International, Economic and Social Affairs, 1983; Holmes, 1983; Torsten and Postlethwaite, Vol. 4, 1985; Working Paper I: Finland, 1981-1982;

Figure 3

School Structure and Mathematics Offerings

by Proportion of Age Cohort

France[1]



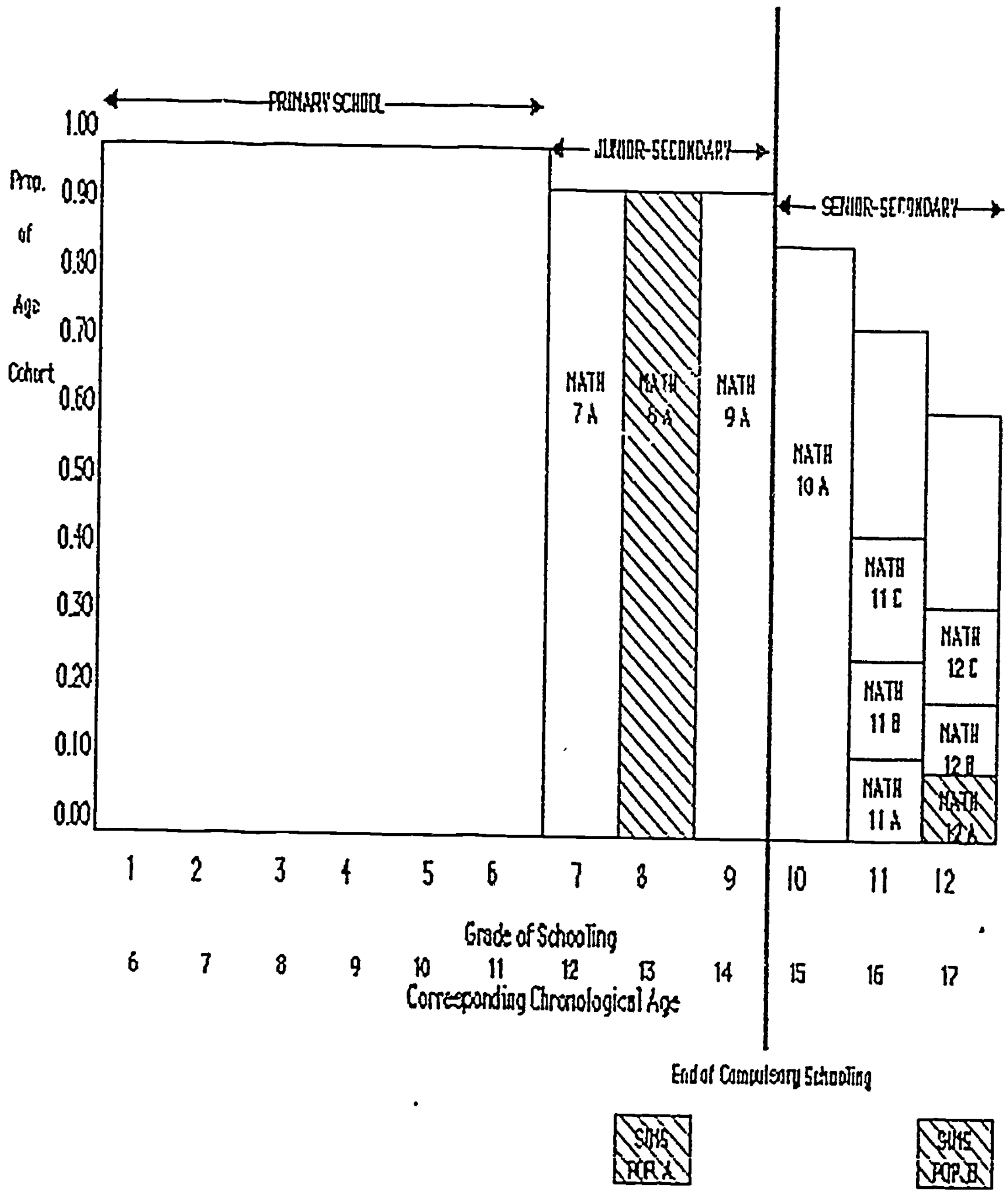
[1] Dept. of International, Economic and Social Affairs, 1983; Torsten and Postlethwaite, Vol. 4, 1985; Working Paper I: France, 1981-1982.

Figure 4

School Structure and Mathematics Offerings

by Proportion of Age Cohort

Israel[1]



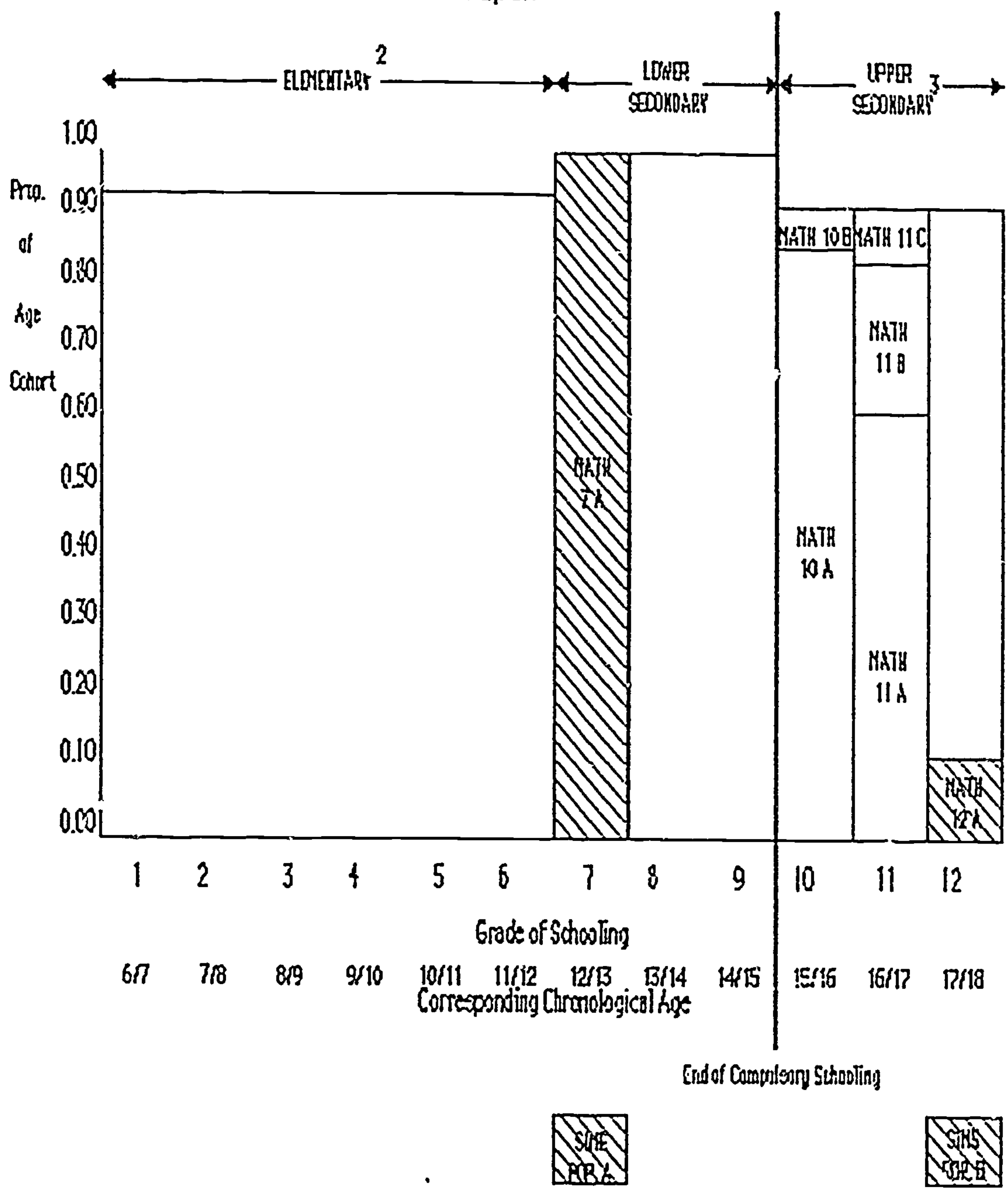
[1]Central Bureau of Statistics, 1981; Torsten and Postlethwaite, Vol. 5, 1985; Working Paper I: Israel, 1981-1982.

Figure 5

School Structure and Mathematics Offerings

by Proportion of Age Cohort

Japan[1]



[1]Dept. of International Economic and Social Affairs, 1983; Torsten and Postlethwaite, Vol. 5, 1985; Working Paper I: Japan, 1981-1982.

[2]There is a .99 enrollment ratio for ages 7-11; the lower ratio is due to an enrollment rate of .49 for 6 year-olds.

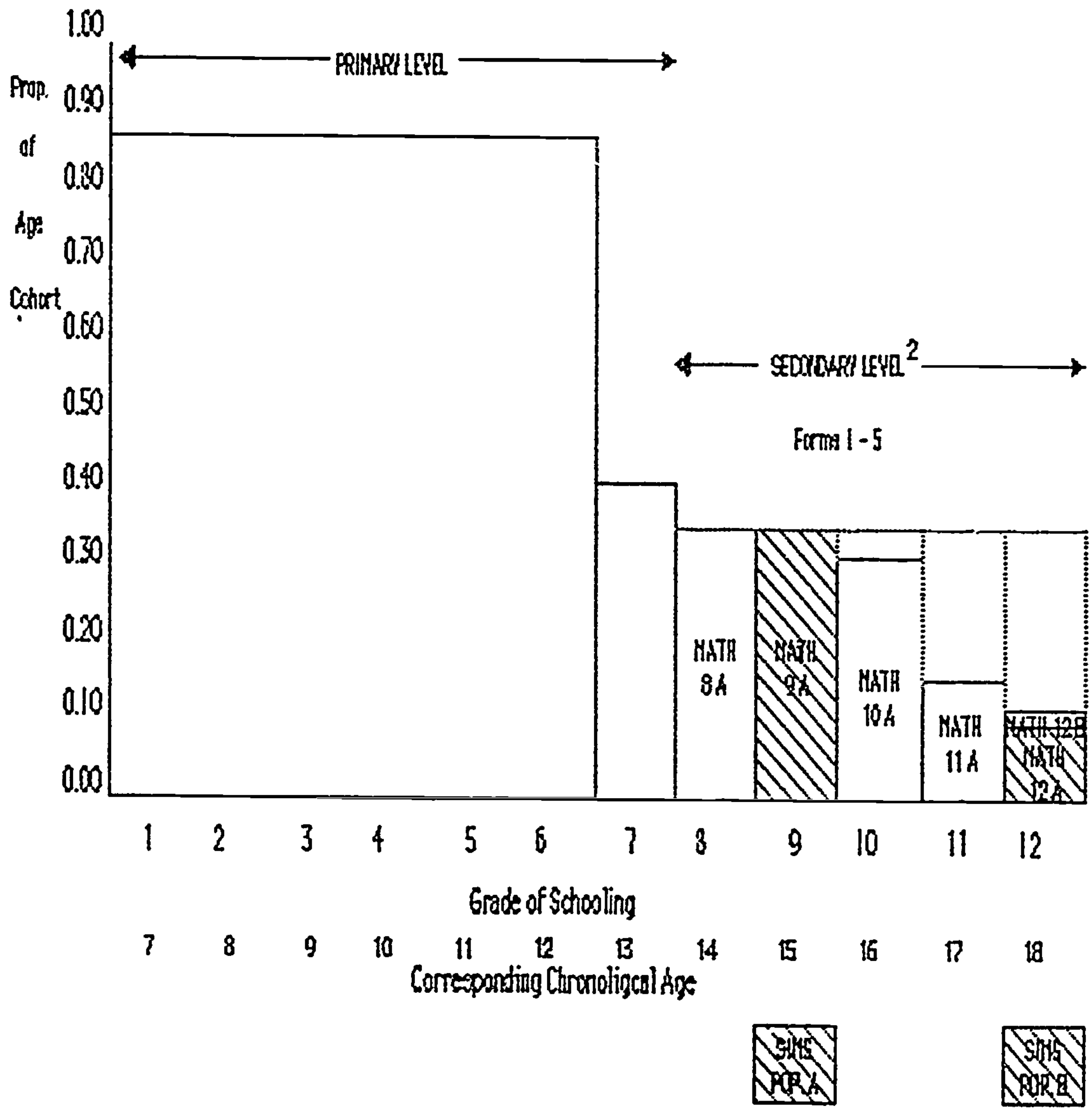
[3]Includes 18 and 19 year olds who are repeaters.

Figure 6

School Structure and Mathematics Offerings

by Proportion of Age Cohort

Swaziland[1]



[1]Dept. of International Economic and Social Affairs, 1983; Department of International Economic and Social Affairs, 1982; Europa Yearbook, 1986; Torsten and Postlethwaite, Vol. 8, 1985; Working Papers I: Swaziland, 1981-1982.

[2]An overall enrollment of .32 of age cohort at the secondary level is reported but a breakdown by grades is not available. This is indicated by the dotted line.

Comparing overall school structure, it can be seen that all six countries have clearly defined primary and secondary levels. Furthermore, France, Finland, Israel and Japan essentially have three level systems: primary, middle and upper. France and Finland offer secondary level technical school alternatives not included in the diagrams. Finland and Swaziland define the entry age at seven; Japan at six or seven and the remaining nations at six. All five developed nations have designated levels of compulsory schooling; Finland, Israel and Japan at grade 9, England and France at grade 11.

Details of mathematics offerings by grade at the secondary level are shown for each country in the models. The mathematics options are labeled by school grade followed by the letters A, B, C, D, or E. In this sequence A represents the longer or more advanced course. Course sequences through the secondary level have the same letter designation. These are not the official names of the courses; the labels have been used to facilitate comparisons. Furthermore, no assumptions should be made regarding similarities between similarly labeled courses of two different countries although it may be that the courses actually include large numbers of common topics. Such commonalities may only be pursued by a detailed study of course curriculums. At the Population A level, four of the six countries, France, Israel, Japan and Swaziland, have one course option; England has three and Finland has two. Details of these courses will be described below. At the Population B level, the terminal year of secondary schooling, there are more course options in all countries. Only some of those include the more advanced mathematics courses.

Age cohort enrollments are indicated by the height of each bar corresponding to a grade or a mathematics course. The placement of the SIMS Populations A and B is indicated by shading. There are striking similarities among the countries with respect to participation. At the Population A level, for all the developed countries, more than .90 of the age cohort is still in school and all who are in school are taking mathematics courses. Swaziland, a developing nation, reports a .32 age cohort enrollment at this level but, in common with the other countries, all of the students who are in school are taking mathematics.

Continuing examination of cohort participation at the terminal level of secondary schooling, it may be seen that in all countries, a smaller proportion is still in school. The fact that this is past the level of compulsory schooling must be considered to be a contributing factor for the developed nations. Participation in mathematics courses, especially the more advanced ones, has generally decreased in all cases, both as a proportion of the age cohort as well as a proportion of those still in school. In France and Finland all students continue to take some kind of mathematics. Comparing the proportion still taking mathematics as a substantial portion of their program (Population B), however, shows surprising consistency. All of the countries enroll less than 20% of the age cohort in advance mathematics classes at the terminal level of secondary schooling. Finland has the largest proportion of the age cohort (.16) enrolled in such courses. Japan is next with a .12 proportional enrollment followed by France, Israel and Swaziland with .10. England has the lowest proportion (.08) of students enrolled in advanced mathematics courses at the terminal year of secondary schooling.

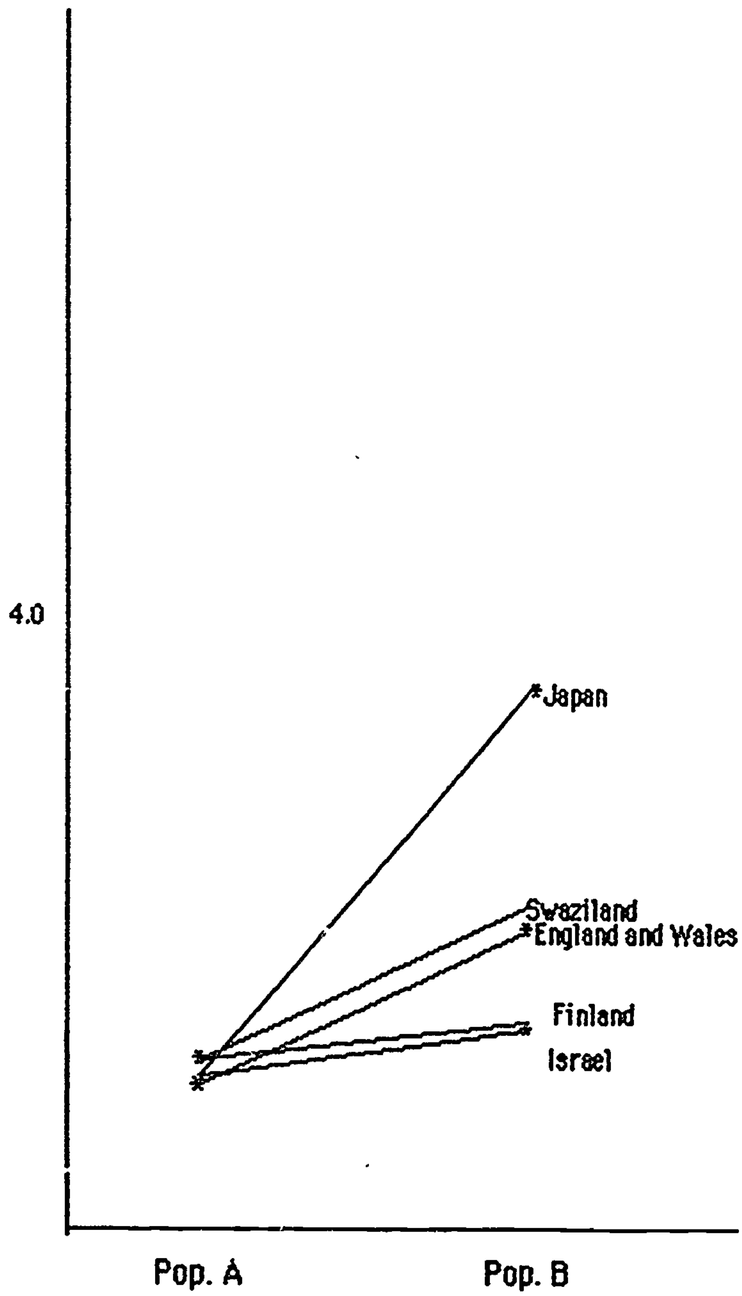
It is thus clear that overall enrollment in mathematics courses decreases at the advanced level; the question of the relative enrollments of male and female students at the entry and terminal levels remains to be answered. The ratios of male to female students enrolled in mathematics courses at the entry and terminal levels of secondary schooling are shown in Figure 7.

Figure 7

Male/Female Enrollment Ratios

by Country

for SIMS Populations A and B[1]



[1]Working Papers I: England and Wales, Finland, Israel, Japan, Swaziland, 1981-1982.

At the entry level of secondary schooling, all six countries have approximately equal numbers of males and females enrolled in mathematics courses. This is to be expected since all students take mathematics at this level. By the terminal level, however, there are distinct differences. The number of males in advanced mathematics courses in Japan outnumber the number of females by more than 3 to 1; in Swaziland and England the comparable ratio is 2 to 1. Only Israel and Finland retain close to equal numbers of males and females in the advanced mathematics course in the terminal year of schooling.

The SIMS Population A level is of particular interest because of the almost universal enrollment and because study at this level is the prerequisite to further study in mathematics. It would be of some interest to pursue consideration of prescribed course content at this level.

Degree of universality for specific topics within each course offered was provided by coordinating centers of the SIMS countries. Universality referred to whether the topic was covered by All, Some, or None of the students following the course. For Population A the questionnaire included five major topics: arithmetic, algebra, geometry, probability and statistics and measurement. Each major topic was broken down into categories; each category was further subdivided into items. Arithmetic included a total of 43 items; algebra, geometry, statistics and measurement included 48, 22, 9 and 11 items respectively. Applying a numerical rating of 2 for a response of All, 1 for a response of Some and 0 for a response of None gives the average figures reported in Table 1.

Table 1

Universality Ratings

Population A[1]

	Arith.	Alg.	Geom.	Prob./Stat.	Measure.
England					
Traditional	1.4	1.0	1.2	0.3	1.6
Modern	1.5	1.3	1.0	0.6	1.4
France	1.1	0.8	0.5	0	0.1
Finland[2]	1.2	1.0	0.9	0.1	2.0
Israel	1.7	1.4	1.3	0.1	2.0
Japan	1.6	1.0	1.5	1.2	2.0
Swaziland	1.4	0.7	1.1	0.5	1.8

[1]Working Papers I: England and Wales, Finland, France, Israel, Japan, Swaziland, 1981-1982.

[2]Universality ratings for the two separate courses reported by Finland were essentially the same and are thus presented as one set of figures.

Care must be taken in interpreting this table. The numbers reported represent averages of all items. A rating of 1.5, for instance, may reflect that some of the topics are taught to all of the students, all of the topics are taught to some students, or some are not taught at all. Therefore, the ratings reported in Table 1 should be viewed as a measure of topic inclusion as well as universality as defined above.

Table 1 shows a degree of uniformity among the course curriculums as conceived at the national levels. In all cases at this level arithmetic still remains an important part of the curriculum. All six countries include algebra topics although to varying degrees. France and Swaziland reported the lowest ratings in algebra; Israel and England's modern course the highest. There were greater variations in reported universality and inclusion for geometry, probability and statistics and measurement but these topics also accounted for a smaller number of items. France reported the lowest geometry rating and Japan the highest; in measurement all except France reported relatively high ratings.

The proportion of time allocated to study of a particular subject is not only an indication of the importance accorded to that subject but must inevitably affect how much is learned. Table 2 reports the total number of hours devoted to mathematics instruction per year as well as the proportion of total time per year and the proportion of total time per week.

The figures for proportion of total time per year and total time per week, where both are available, are the same. Thus, it can be concluded that mathematics instruction is allocated evenly over the school year. There is a wide range of instructional time allocation among the six countries included in this study. The total number of hours of mathematics instruction at the Population A level varies from a low of

83.2 in Finland to a high of 156.5 for Swaziland. At the Population B level, the range is from 67 hours in Finland to a high of 180 hours for England and Wales. There is a qualification in the low number of classroom hours for Finland at the Population B level in that time is allowed for preparation for final exams. England, however, not only has the highest total number of hours but also the largest proportion of time devoted to mathematics instruction. Recall, however, that England was also the country with the lowest age cohort enrollment at this level. Comparing change in time spent on mathematics instruction between the two SIMS levels, five of the six countries, England, Finland, France, Japan and Swaziland show an increase. Israel shows a decrease in proportion of time from Population A to Population B level; however, the total number of hours devoted to mathematics instruction increases. The increase in time allocation is to be expected in view of the definition of the SIMS Population B.

Table 2

Time Allotted to Mathematics Instruction

by Total Number of Hours and as a Proportion of Total Time

SIMS Populations A and B

	Math. hrs. per yr.[1]	Prop. of total time/yr.[1]	Prop. of total time/wk.[2]
Population A			
England and Wales	117.3	0.14	0.14-0.18
Finland	83.2	0.10	0.10
France	128.5	0.13	NA
Israel	133.3	NA	0.17
Japan	99.3	0.12	0.12
Swaziland	156.5	NA	0.15
Population B			
England and Wales	180.0	0.22	0.21
Finland[3]	67.0	0.12	0.13
France	NA	NA	NA
Israel	150.0	NA	0.08
Japan	149.0	0.15	0.15
Swaziland	NA	NA	0.18

[1]International Mathematical Curriculum, Chapter 5, 1984.

[2]Working Paters I: England and Wales, Finalnd, France, Israel, Japan, Swaziland, 1981-1982.

[3]In Finland teaching at the terminal secondary level ends early after which point the time is used to prepare for final exams.

Conclusions

The current study examined the mathematics curriculums of England, Finland, France, Israel, Japan and Swaziland as defined at the national levels with the purpose of comparing course offerings and age cohort participation. The focus was at the two points of schooling studied in detail by the Second International Mathematics Study; the first at the median age of 13 years and the second at the terminal year of secondary schooling.

The countries chosen for this study varied along different dimensions. Five of the six are developed nations; all five developed nations have defined levels of compulsory schooling. Three of the six are western European nations; the remaining three are geographically diverse. As a nation, Israel has a unique linguistic situation but all of the schools which were considered were essentially unilingual. Five of the six, all except England, have national curriculums; four, England, Finland, Japan and Israel allow some level of decision making regarding standards at the local level.

With respect to mathematics offerings, the number of course options were found to vary. At the SIMS population A level, the 13-year olds, four of the six nations, France, Israel, Japan and Swaziland, have only one offering; England and Finland have more than one. In all cases the number of course offerings increase after this and at the terminal year of secondary schooling there are generally more options. The exception is Japan where multiple options are available between the two SIMS popultion levels but only one is available in the terminal year.

At the entry level of secondary schooling all of the developed countries have a signficant proportion of the age cohort enrolled in school and taking mathematics courses. Except for England, within each country, all students take essentially the same course at this stage. Making an inter-nation comparison, all courses include a substantial amount of arithmetic as well as algebraic topics. Proportion of total instructional time spent on mathematics instruction varies widely . ' this level. Numbers of male and female students are approximately equal.

At the terminal year of secondary schooling there are some common trends but also the appearance of distinct differences. The proportion of the age cohort still in school has fallen off for all countries. In two of the countries, Finland and France, all students still in school continue to study some mathematics. Nevertheless, the proportion of students taking advanced mathematics courses in all countries has decreased dramatically to a range of between .08 and .16 of the age cohort. England has the lowest proportion of students in such classes; Israel has the highest.

With respect to male to female enrollment ratios in the advanced courses, it was found that for those nations where data was available, only two, Finland and Israel, retain approximately equal proportions of male and female students. Of the remaining three, two, England and Swaziland, report males outnumbering females by a ratio of 2 to 1 and Japan reports a comparable ratio of 3 to 1.

Reagarding instructional time allocated to mathematics instruction, there is a great range in the proportion of such time at the population B level. Although all countries report a greater number of total hours than at the popuation A level, England has the greatest proportion and Israel the smallest. It is interesting to note that England also enrolls the lowest proportion of the age cohort in its advanced mathematics courses, and is the only country with curricular decisions at the local level and multiple mathematics course offerings at the secondary entry level.

For all six countries included in this study, the pattern of dropping enrollments in mathematics courses persists as well as a decrease in the proportion of females enrolled in the advanced courses. Although the number of mathematics offerings increases through the secondary years, the proportion of the population availing themselves of such options at the advanced levels remains low.

A study such as this one highlights the low proportion of students completing their secondary education with the necessary background to prepare for scientific and technological careers. Although achievement may vary internationally, common problems of encouraging participation by students, both male and female remain.

REFERENCES

Central Bureau of Statistics (1981). Statistical Abstract of Israel. No. 32. Jerusalem.

Crosswhite, F. J. (1984, April). Comments on the U. S. data from the Second International Mathematics Study. Paper presented at the meeting of the National Council of Teachers of Mathematics, San Francisco, CA.

Crosswhite, J. F., Dossey, J. A., Swafford, J. O., McKnight, C. C., and Cooney, T. J. (1985). Second international mathematics study summary report for the United States. Champaign, IL: Stipes Publishing.

Damerow, P. and Westbury, I. (1985). Mathematics for all -- problems and implications. Journal of Curriculum Studies, 17, no. 2, 175-184.

Department of International Economic and Social Affairs Statistical Office. (1983). Demographic yearbook: Thirty fifth issue. New York: United Nations.

Department of International Economic and Social Affairs Statistical Office. (1982). Statistical yearbook: Thirty third issue. New York: United Nations.

The Europa Yearbook: 1986. A World Survey, Vol. I. (1986). London: Europa Publications Limited.

The Europa Yearbook: 1985. A World Survey, Vol. II. (1985). London: Europa Publications Limited.

Husen, T., Ed. (1967). International study of achievement in mathematics: A comparison of twelve countries. Stockholm: Almqvist and Wiksell.

Husen, T. & Postlethwaite, T. N., eds. (1985). The international encyclopedia of education: Research and studies, volumes 1 - 9. Oxford: Pergamon Press.

The International Mathematics Curriculum, Vol. I. (1984, August). Draft copy from University of Illinois at Champaign-Urbana.

Holmes, B., Ed. (1983). International Yearbook of Education, Volume XXXV - 1983: Educational development trends. Paris: UNESCO.

Lundgren, U. P. (1977). Model Analysis of Pedagogical Processes. CWK Gleerup: Map Gruppen. Stockholm: Stockholm Institute of Education, Dept. of Educational Research.

McKnight, C. C. (1980). Classroom processes in mathematics instruction: On characterizing the implemented curriculum. In H. G. Steiner, ed., Comparative studies of mathematics curricula: Change and stability, 1960 - 1980. Bielefeld, FRG: Institut fur Didaktik der Mathematick der Universitat Bielefeld.

Travers, K. J. (1985, July). The second international mathematics study: An international perspective. University of Illinois at Urbana-Champaign. Unpublished manuscript.

van der Blij, D., Hilding, S., and Weinzweig, A. I. (1980). A synthesis of national reports on changes in curricula. In H. G. Steiner, ed., Comparative studies of mathematics curricula: Change and stability, 1960 - 1980. Bielefeld, FRG: Institut fur Didaktik der Mathematick der Universitat Bielefeld.

Working Paper I: Details of Mathematics Syllabus: England and Wales, Finland, France, Israel, Japan, Swaziland. (1981-1982). Second International Mathematics Study at the University of Illinois at Urbana-Champaign. Unpublished raw data.