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ABSTRACT

This paper describes curriculum content in two areas--mathematics and international studies--in the secondary schools of Canada, Japan, West Germany, the USSR, and the United States. Relevant background on teacher preparation and on the structure and organization of secondary schooling in each country is introduced to provide a context for the information provided. After the introduction, the paper's second part summarizes major conceptual and methodological issues in comparative studies and in comparative curriculum. In the third section, the content of the mathematics programs is presented with data on when that content is introduced into the program in each country. A sampling of instructional practices from various countries which may have relevance to mathematics education in the United States is included, and issues in mathematics education are examined. The international studies component of the broader social studies curriculum is described and discussed in the fourth section, and case histories of the curriculum in each country are presented. In the fifth part, concluding observations draw attention to the issues of the nature, possibilities; and problems of comparative curriculum study, the two curriculum areas, teachers and instruction, and considerations of curriculum change and policy making. (JD)

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A COMPARATIVE REVIEW OF CURRICULUM:
MATHEMATICS AND INTERNATIONAL STUDIES IN
THE SECONDARY SCHOOLS OF FIVE COUNTRIES

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Submitted to
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1. INTRODUCTION

1.1 Scope and Purpose

The purpose of this paper is to describe curriculum content in two areas--mathematics and international studies--in the secondary schools of five advanced industrial countries. Some relevant background on teacher preparation and on the structure and organization of secondary schooling in each country will be introduced to provide a context for the information provided. The central objective is to identify what students are taught at various levels and to highlight what appear to be noteworthy recent developments in the several nations observed.

1.2 Limitations

The advanced countries chosen for this study were selected to represent a range of different geographical regions and political systems. It was assumed that, as highly developed nations, they would demonstrate an instructive array of ideas and practices in the curriculum areas selected. They were, however, not sampled on the basis of any specified a priori selective principles. In their absence, and in the absence of any preliminary theory relating to comparative study in general or curriculum as a means of achieving educational goals, the possibilities for making inferences and drawing conclusions are strictly limited.

The report is further limited by the data and sources available and by time.* It has not been possible to confirm the representativeness of the information presented, its recency, or whether, according to the judgements of other experts in the U.S.A. and in the several countries under review, the

*The authors have been given to understand that additions and revisions where necessary may be made in the next four weeks after submission.

generalizations made by the authors are well-founded. The authors believe that the data are accurate, representative, and reasonably comprehensive and current, and plan to give attention to confirming this.

1.3 Organization

The following section of the paper begins with a summary of some major conceptual and methodological issues in comparative studies in general and in comparative curriculum in particular. It contains a brief discussion of the nature of the two subject areas as specific foci for comparison. The section concludes with profiles of the secondary school organization and teacher preparation in each of the five countries, with some general observations on their common and divergent features.

In part three, the content of the mathematics programs is presented, together with data on when that content is introduced into the program in each country. This is followed by some observations about the content of U.S. mathematics curriculum in the context of international data, and a sampling of instructional practices from various countries which may have relevance to mathematics education in the U.S. This part concludes with some reflections upon issues in mathematics education as they bear upon the American scene, in the light of findings from other countries.

In part four, the international studies component of the broader social studies curriculum is described and discussed. After some consideration of the fragmented and diverse nature of this element, and of its significance in the total education of young people, case studies of the curriculum are presented. For each country, information is given on the goals and content of international studies, and on selected aspects of instruction, teaching materials, extra-curricular activities, and other special features. The section concludes with a general discussion of issues in the United States

in this curriculum area.

In the final section, no attempt is made to summarize the findings. Instead, attention is drawn to some of the issues raised in the paper: The nature, possibilities and problems of comparative curriculum study; the two curriculum areas and the relation of teachers and instruction to them; and some considerations of curriculum change and policy-making.

TABLE OF CONTENTS

1. INTRODUCTION	1
1.1 Scope and Purpose	1
1.2 Limitations	1
1.3 Organization	1
2. COMPARATIVE CURRICULUM STUDY: PROBLEMS, METHODS, AND CONTEXTS	4
2.1 Problems and Purposes of Comparative Study of Education	4
2.2 Comparing Curriculum in Mathematics and International Studies	6
2.3 National Profiles of School Systems:	12
A. Canada	12
B. Japan	15
C. Federal Republic of Germany	18
D. U.S.S.R.	21
E. U.S.A.	25
2.4 The Nature of the Sample of Countries	28
3. MATHEMATICS CURRICULUM IN FIVE COUNTRIES	29
3.1 Role of Mathematics in School Curriculum	29
3.2 Case Studies of Mathematics Education	30
A. Canada: Ontario	30
B. Japan	32
C. Federal Republic of Germany	34
D. U.S.S.R.	35
E. U.S.A.	36
3.3 Comparative Analysis of Selected Mathematical Topics	38
3.4 Some Noteworthy Programs and Practices	43
A. Curriculum Revisions--Geometry--Canada	43
B. Computers and Mathematics--Federal Republic of Germany	44
C. Quality of Teacher-Student Transactions--Japan	45
D. "New Math" in the USSR	46
3.5 Issues in Mathematics Education in the U.S.A.	49
A. Background Curricular Studies in the U.S.	49
B. Does More Mean Worse?	51
C. Holding Power of Mathematics Programs	52
D. External Examinations	57
E. The Content of the Curriculum	59
F. The Impact of Computing Technology on the Curriculum	60
G. Minimal Mathematical Competencies	61
H. Fostering of Talent	61

4.	INTERNATIONAL STUDIES CURRICULUM IN FIVE COUNTRIES	64
4.1	International Studies in the Social Science Curriculum.	64
4.2	Case Studies of the International Component in the Curriculum	65
	A. Canada	65
	B. Japan	66
	C. Federal Republic of Germany	72
	D. U.S.S.R.	76
	E. U.S.A.	79
4.3	Issues in International and Social Studies in the U.S.A.	90
5.	CONCLUDING OBSERVATIONS	93
5.1	On Comparative Curriculum Study	93
5.2	On Mathematics and International Studies	94
5.3	On Teachers and Instruction	96
5.4	On the Processes of Curriculum Change and Policy-Making	97
	REFERENCES	99
	APPENDIX A: Second IEA International Mathematics Study: Participants.	107
	APPENDIX B: Hours Spent on Mathematics Homework and Instruction	108
	APPENDIX C: Key to Mathematical Items (Section 3.3) Figure 7	109

2. COMPARATIVE CURRICULUM STUDY: PROBLEMS, METHODS, AND CONTEXTS

2.1 Problems and Purposes of Comparative Study of Education

Like other areas of cross-national study, comparative education continues to grapple with serious conceptual and methodological problems. They range from equivalence of terms and data across cultures, to questions of representativeness and reliability, as well as the familiar social science difficulties with handling quantifiable and non-quantifiable information. Furthermore, deriving meanings or seeking explanations from the data is fraught with ambiguities caused by cultural bias and differences in research theory and methods. To attempt comparative analysis is to confront all of these issues (Noah and Eckstein, 1969; Bereday, 1964)

Over a century and a half ago, some comparative educators envisioned the study of curriculum and instructional methods as a practical means to enable educators to improve school practices in their own countries. From Horace Mann to the first Commissioners of Education in the U.S.A., the precedent for reporting on foreign school practices was well established (Mann, 1844; Fraser, 1964; Fraser and Brickman, 1968).

The literature comparing curriculum is not great, but it abounds with examples, items of information, and case studies of parts of what is taught. In more recent years, Sputnik inspired a series of rather uncritical accounts of the presumed superiority of Soviet schooling, particularly in science, mathematics, and engineering curricula. U.S. educators subsequently "discovered" a number of innovative practices in British Infants' Schools and publicized them extensively. But such efforts to disseminate information based on individual case studies,

5

often in the form of personal, impressionistic accounts, must be regarded with caution, especially when touched by a certain missionary fervor.

Yet, as educational observers have become more aware that schooling is so much bound up in the social and economic progress of nations, they perforce look beyond their borders for knowledge, insights, and helpful hints. This gave impetus to the burgeoning of early comparative education work in the nineteenth century, a period when the then advanced nations of the world were founding their public education systems. Similar motives prompted the rapid growth of comparative study from mid-twentieth century on, as developing nations sought to progress, and as the developed nations attempted to meet new and urgent social and educational demands. If education is regarded as one of the tools for national advancement, then curriculum lays out part of the plan and serves as the means for achieving it. As such, it warrants systematic study.

In all comparative study, it is important to recognize the context of alternative models of schooling. What King (1979) calls "the inherited context," refers to the precedents established by a nation's historical and cultural traditions. In addition, current conditions, the recent interplay among political, economic, social, and intellectual forces, are also parts of the necessary context to illuminate educational facts.

2.2 Comparing Curriculum in Mathematics and International Studies

As Anderson has observed (Walker, 1976), the curricula of different nations may be regarded as cultural forms. They contain many similar items, but each forms its own unique configuration. Certain elements are universal (mathematics appears to be one of these), others are parochial (history, geography, civic education, for example, abound with these). But this speaks merely to the cognitive elements in a curriculum. In the affective domain there are also universal elements (common human desires and emotions, as expressed for example, in great literature) as well as parochial sets of values and attitudes (nationalistic lessons, for instance). These characteristics make it easier to codify curriculum content in some school subjects than others. As the IEA studies show, mathematics and science content are easier to compare across nations than other subjects. Social studies (or history and geography, or civics) and especially that portion dealing with international studies, are especially elusive, containing as they do a complex mix of cognitive and affective elements, both universal and parochial.

The two subject areas under consideration in this report differ also in other respects. Mathematics, for example, is considered to be essential to all high school students by more people (97 per cent) polled in the Eleventh Annual Gallup survey than any other subject. Civics and U.S. history are

7

third and fourth; science comes fifth in the relative rankings of importance. However, the low ranking of foreign languages and of teachings about the interdependence of nations/ foreign relations, indicates the relatively low status given to this area in the public view (Gallup, George H., Phi Delta Kappan, September 1979, reprinted from the NSF Science Educational Databook, 1980, page 69).

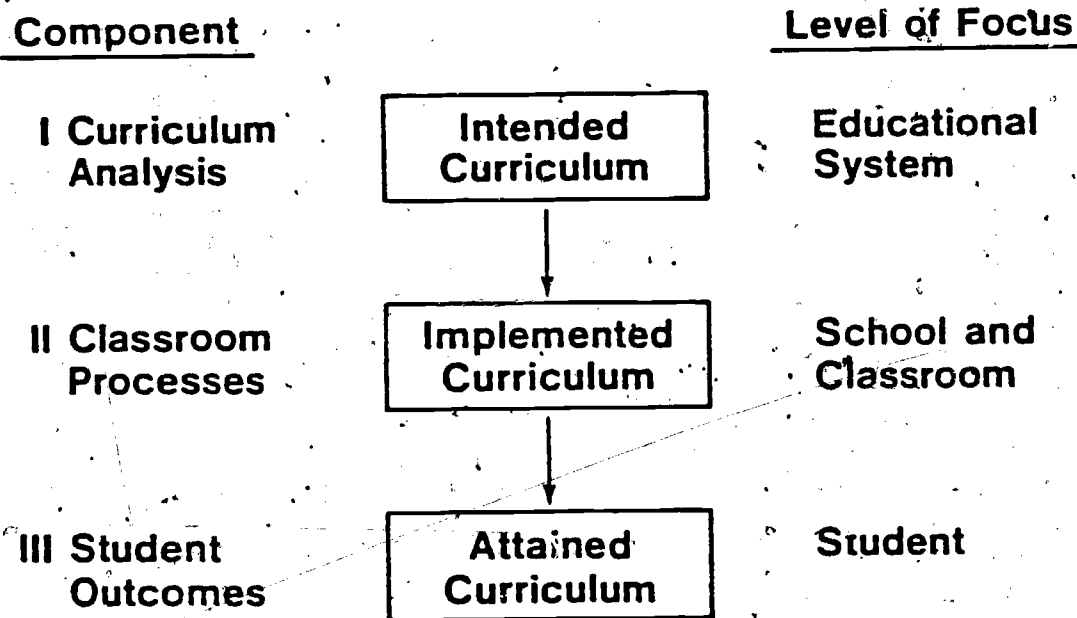
Table I: Public view of subjects essential to all high school students

	National Totals		
	Essential %	Not Too Essential %	Don't Know/ No Answer %
Mathematics	97	1	2
English grammar & composition	94	3	3
Civics/government	88	8	4
U.S. history	86	11	3
Science	83	14	3
Geography	81	16	3
Physical education	76	21	3
Interdependence of nations—foreign relations	60	32	8
Music	44	52	4
Foreign language	43	53	4
Art	37	58	5

A second consideration is that a curriculum is more than a syllabus or course outline, it is the collection of organized learning experiences that a school provides. A country may or may not have a national syllabus, but how one is implemented depends on many factors, including teachers, textbooks, local decisions and interpretations, school resources, student background and ability, and so on. The distinctions among the official curriculum, the taught curriculum, and the learned curriculum may be considerable. In this regard, Fey (1979) has commented upon the findings of the National Science Foundation's studies of the status of science and mathematics education:

8

FIGURE 1: Three Aspects of the Curriculum (from "The Second IEA Mathematics Study," Bulletin 5, November 1980, page 10)



9

...the most discouraging feature of the three NSF studies is the consistent pattern of great differences between apparent reality of mathematics education in most schools and the recommendations or practices of many prominent teachers, supervisors, and professional organizations. (page 503)

A complete analysis of school curriculum in a country would have three components. It would look at the curriculum as it is intended to be. That is, it would examine the set of expectations for learning a subject which are held by a ministry of education, a state director of curriculum, or a local board of education.

The second component of the study would deal with how the curriculum is implemented in the classroom. It would be important to know, for example, the extent to which curricular guidelines are actually followed by classroom teachers. An instructive example is provided by an account of a mathematics curriculum revision in Western Canada. A new program for the tenth grade included units on vectors and on consumer mathematics. Yet a survey of the grade ten mathematics teachers indicated that over 60% of them did not teach vectors and over 50% did not teach the material on consumer mathematics (Robitaille, 1980, pp. 102-103).

With respect to implementing the curriculum, we are interested not only in how much mathematics is taught, but how that mathematics is taught. Davis and Romberg (1979), in their analysis of mathematics education in the USSR report on the "Soviet teaching style" as follows:

Given what we knew of the excellence of Soviet mathematical research, of the difficult Soviet competitive exams and their emphasis on nonroutine (indeed, very creative) problem solving, and on such Soviet literature as we had read, we were entirely unprepared for the teaching that we observed in Soviet classrooms. It consisted entirely, as nearly as we could judge, of rote instruction! Students are told that this is the hyperbolic sine ($\sinh x$), they are told that its graph looks like this, and so on. (page 18)

10.

The third component of such a thorough study would look at student achievement, (the curriculum as attained by the students) both in terms of knowledge and attitudes, in the light of curricular intentions and implementation.

Such a detailed study of the curriculum; however, goes well beyond the scope of this paper. It does, in fact, form the basis for the Second IEA* International Mathematics Study which is now underway in 24 countries (see list of participating countries in Appendix A). It is also noted that U.S. participation in this comprehensive investigation is being supported jointly by the National Science Foundation and the National Institute of Education.

Experience in conducting previous IEA studies further illustrates this problem. Test instruments were constructed on the basis of official curricula and some consensus by the participants from each nation about the attention given to particular topics within a subject. Despite the care taken to ensure that the tests were in fact directed at topics common to all the participating nations, subsequent classroom teacher judgements of

*The IEA is an international, non-profit-making scientific association incorporated in Belgium for the principal purposes of (a) undertaking educational research on an international scale; (b) promoting research aimed at examining educational problems in order to provide facts which can help in the ultimate improvement of educational systems; and (c) providing the means whereby research centres in the various member countries of IEA can undertake co-operative projects. The current chairman of the IEA Council is Professor T. Neville Postlethwaite of the University of Hamburg, FR Germany. The Mathematics Project Council, responsible for the Second Mathematics Study, is chaired by Roy W. Phillipps of the New Zealand Department of Education, who is also International Project Co-ordinator for the Study. Travers is Chairman of the International Mathematics Committee (IMC) which is designing the Study and developing the international instruments. Other members of the IMC are: Sven Hilding, Sweden, Edward Kifer, United States, Gerard Pollock, Scotland, and James Wilson, United States. A. I. Weinzeig, United States, is consulting mathematician for the IMC.

11

their students' opportunity to learn revealed substantial variations. This information served as an important direct description of the actual implemented curriculum, and one which is significant for evaluating student achievement.

In this present paper, emphasis is placed instead upon the intended curriculum. That is to say, we will summarize and discuss data provided by authoritative groups, typically within the country, concerning what is intended to be taught in the schools of that nation. To a much less extent, due to the lack of data, we will report on what is actually taught and how it is taught.

2.3 National Profiles of School Systems

A. Canada: Ontario

Each Province is responsible for conducting the school system in its territory. Despite efforts of regular and occasional meetings of the several Provincial Ministries of Education to achieve consensus, physical and cultural differences as well as historical precedents ensure regional autonomy in educational policy and practice. Yet similarities are also widespread. The information that follows relates to Ontario, a more populous and influential Province, as well as a fairly representative one.

Government of Ontario funded schools (Public and Roman Catholic Separate) account for more than 95 percent of the school population for the ages 5-16. The Roman Catholic schools (Separate Boards) contain approximately 30 percent of the age 5-13 cohort decreasing to 10 percent for ages 14-15. Private schools account for approximately two percent of the age 5-14 population.

The Ontario Ministry of Education provides Curriculum Guidelines according to a divisional structure: Primary (junior kindergarten-grade 3), Junior (grades 4-6), Intermediate (grades 7-10) and Senior (grades 11-13). All schools in the Province do attempt to conform to Ministry Guidelines for their curriculum and program structure.

Virtually all Public, Separate and Private secondary schools are comprehensive, with most offering instruction at three levels beginning at grade 9: Advanced, General and Basic; a fourth level, Modified was added in 1980. Though all schools offer Advanced and General level courses, the Basic and Modified levels may be more typically found in Public secondary schools.



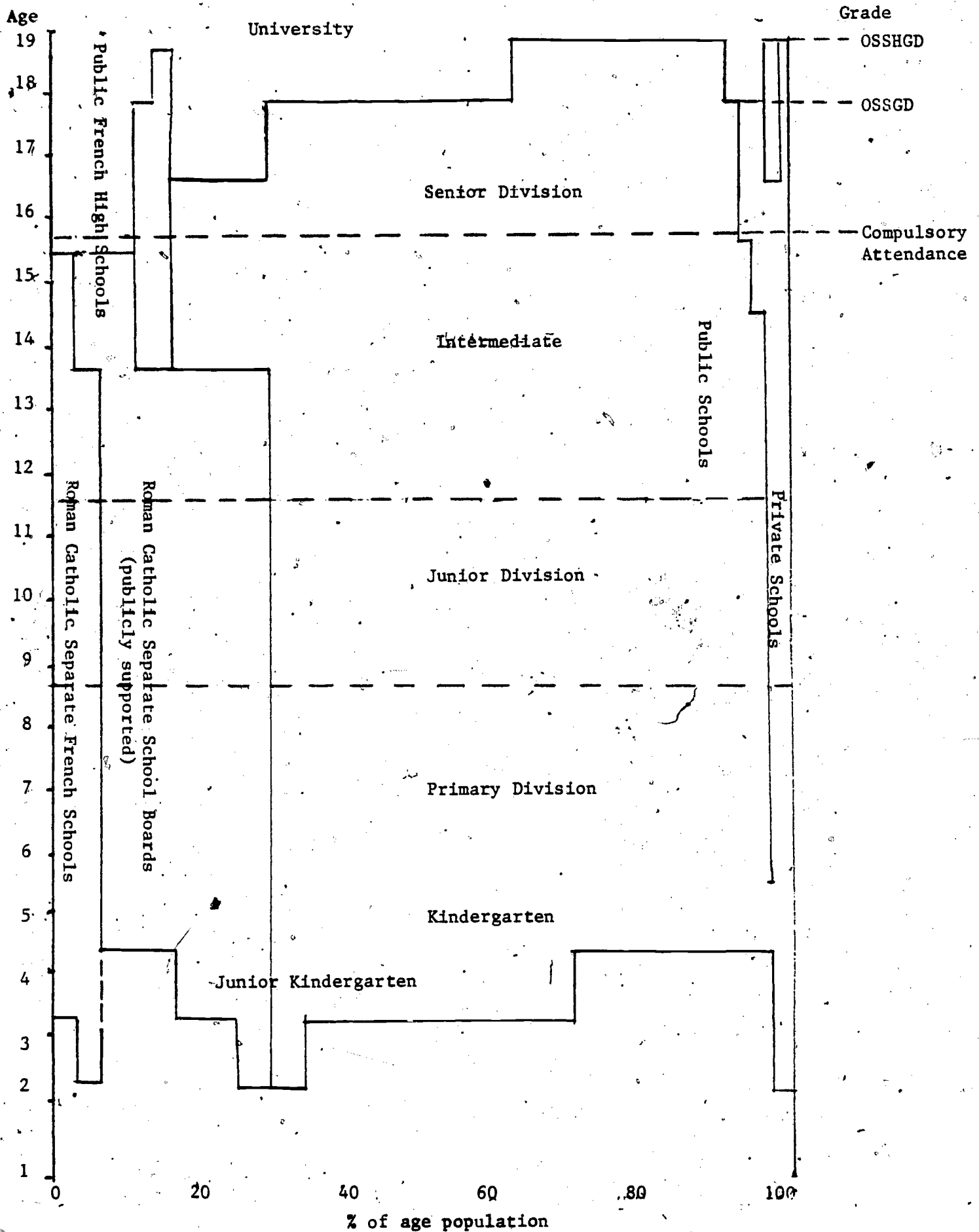
Students may legally stop attending school when they reach the age of 16, but 91.9 percent of the age 16 population continues to attend school. At the completion of grade 12, the Ontario Secondary School Graduation Diploma (OSSGD) is conferred. The Ontario Secondary School Honours Diploma (OSSHGD) is attained by completion of grade 13. Obtaining the latter certificate requires the completion of six honour courses (grade 13) and is normally required for admission to an Ontario university but not for universities in other provinces. Approximately 62 percent of the age cohort achieve the OSSGD and 24 percent the OSSHGD. Approximately 14 percent of the age cohort register in an Ontario university the year following their graduation.

Teacher-training in Ontario is the responsibility of Provincial Universities' Faculties of Education. Two types of programs exist: consecutive training in which candidates attend a Faculty of Education for a one-year Bachelor of Education degree following receipt of a university bachelor degree and concurrent training in which a Bachelor of Education is earned as the main undergraduate degree. The latter procedure is less prevalent being a more recent innovation in Ontario.

Prospective teachers for the Senior and Intermediate levels must elect two areas of specialization. Selection of mathematics education as the main option at the Senior level usually requires the successful completion of five university-level mathematics courses and the Faculty of Education mathematics teacher program. Selection of mathematics as the secondary option at the Senior level or as an Intermediate option requires two university-level mathematics courses and completion of a faculty's training program. Teaching at the Primary or Junior level requires a Bachelor of Education earned in either a consecutive or concurrent program.



Figure 2: Structure of the School System: Canada (Ontario)



-B. Japan

School administration in Japan is highly centralized, though responsibilities for implementation are delegated to regional and local authorities and participation in reform efforts and planning is widespread.

Compulsory schooling in Japan begins in the first April after a child turns six years old. After completing a six-year elementary school, children go on to a three-year lower secondary school. While both public and private schools are available, over 96% of students attend public schools run by the local government through lower secondary school. National schools are available, but less than 1% of the students may attend. Attendance is compulsory for all children through the first nine years. Of those who complete lower secondary school, over 90% continue to upper secondary schools. Some differentiation into specialized schools is done at this point (55% of the students are in General Secondary schools). At the upper secondary level, approximately 70% of the students attend public schools and 30% are in private secondary schools.

Minimum requirements for teachers vary according to school level and class of certificate. At the lower secondary level, a second-class certificate can be obtained by two years study beyond the upper secondary school. Through four years study (equivalent of Bachelor's degree) a first-class lower secondary or second-class upper secondary certificate is obtained. The first-class upper secondary certificate requires one year beyond the Bachelor's degree, studying exclusively mathematics subjects. All teachers of mathematics have the equivalent of Bachelor's degree.

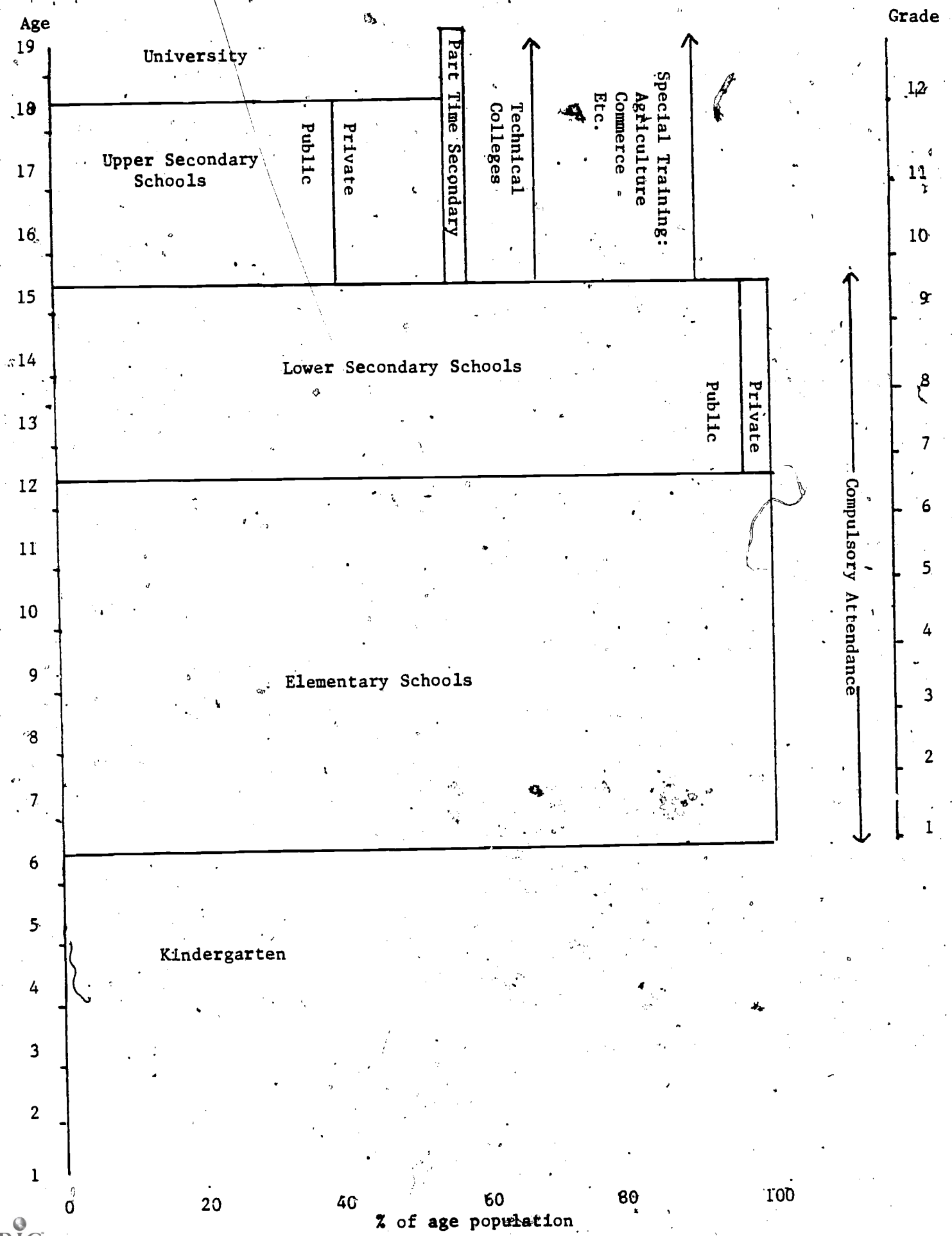
Entrance examinations are given for national and private schools at the elementary and secondary levels. These examinations are highly competitive, since the number of spaces is limited. Upper secondary schools and universities also require a competitive entrance examination.

Students who fail the entrance examination for their desired university often continue their preparation after graduation to try again the next year. In many large cities, there are private schools that give lessons to prepare for the next examination. Also, in many cities, private tutoring classes are becoming popular with elementary and lower secondary pupils. These students receive special tutoring outside of school to strengthen learning and avoid failure on upper secondary entrance examinations.

In 1977, the University Entrance Examination Center was formed to develop an entrance examination that could be used by all universities throughout the country. Students may be admitted on the basis of achievement results on the Center Examination or on the basis of results on a second examination given by each university.



Figure 3: Structure of the School System: Japan



C. Federal Republic of Germany

As in the case of Canada, Germany is a federation of largely autonomous regions so far as educational provisions are concerned. Still, historical precedents ensure important similarities despite regional variations.

Enrollment in the four-year elementary school is generally at the age of six. After these four years, the structure of the schools differs according to the practices of the federal states. During the fifth and sixth school years, students are still together in the Foerderstufe in some federal states. In others, the Gymnasium (academic school leading to university study) begins already in the fifth grade. After the seventh school year, the Hauptschule (until grade 9 or 10), the Reaschule (until grade 10) and the Gymnasium (until grade 13) are, in most cases, run as parallel schools. In some areas there are also comprehensive schools which offer from ten to thirteen years of schooling.

19

During the past ten years, the selection of courses has been introduced in grades 11-13. Students may choose two or three subjects (such as mathematics and physics) for specialized study. The thirteenth grade terminates in the Abitur, an examination which entitles graduates to enter any university in the Republic.

Teacher education is provided mainly for three different teaching careers:

- a). first to tenth years of school ("Grund- und Hauptschulen");
- b). fourth/sixth to 13th school year ("Gymnasien");
- c). vocational education.

In general, teachers are prepared in two or more school subjects.

The preparation is in two stages:

- a). scientific studies for 7 to 10 semesters at a university or teachers college;
- b). practice teaching in school, lasting between 1 and 2 years.

Until recently, teacher education was offered by two types of higher education institutions, teachers colleges (for teachers of grades 1 to 10) and universities (for teachers at Gymnasien and Berufsschulen).

Today, however, there is a unification of teacher training programs which corresponds to similar movements in other countries to integrate content and methods in the schools.

Figure 4: Structure of the School System: F.R.G.

21

D. U.S.S.R.

Education in the Soviet Union is the responsibility of the several Republic Ministries, until the university and technical levels. However, policy and practice vary little among the nominally autonomous regions, and the model provided by the most populous and influential republic (the R.S.F.S.R., that is the Russian Republic) tends to be followed throughout the nation.

The USSR system of public education extends from pre-school through secondary school and to institutions of higher learning. (See Figure 5)

). General education consists essentially of two phases: the compulsory eight-year school (ages 7-15) and upper grades IX-X, additional two years of secondary school. Completion of grade X qualifies students for admission to any higher educational institution.

There are four types of general schools within the secondary general education structure.

1. Primary school, consisting of Grades I-III (nachal'naia shkola). This school may be separate or within the structure of the eight-year or ten-year schools. In the primary grades, the pupils are taught by a general class teacher for all subjects and by subject specialists from Grade IV onwards.

2. Incomplete secondary, eight-year general-education polytechnical (vos'miletnaia shkola). This school may be separate or part of the ten-year general school.

3. Senior secondary general-education polytechnical school (srednie shkole), consisting of the upper grades, IX-X (XI). This senior secondary school is established either separately or in combination with the eight-year school.

4. Complete secondary, ten-year general-education polytechnical school, consisting of Grades I-X (XI).

The academic year, which is divided into four academic quarters, begins in September and varies in duration from thirty-five weeks for Grades I to VII to thirty-eight weeks for Grades IX-X. Classes are held six days a week.

Teacher Qualifications. Teacher education (both pre-service and in-service) is primarily the responsibility of the Ministry of Education of the USSR. There are three basic types of teacher-training institutions: pedagogical schools for teachers of kindergarten and grades I-III; pedagogical institutes for teachers of the middle and upper grades of the secondary general schools; universities, which provide about 15% of the annual number of beginning teachers. Courses of study at the universities are directed more at subject matter than professional training (Shabanowitz, op. cit., pp. 82-84).

Since teachers of the primary grades teach all subjects, there is no subject specialization in the pedagogical schools. The pedagogical institute is emerging as the major source of secondary school teachers. A five year program of subject matter specialization (including physics and mathematics, biology and chemistry, and geology) is provided. Experimental schools associated with the institutes are available for practice teaching and for research.

An important feature of Soviet teacher education is in-service training which is conducted by a network of Institutes for Teacher Improvement throughout the country.

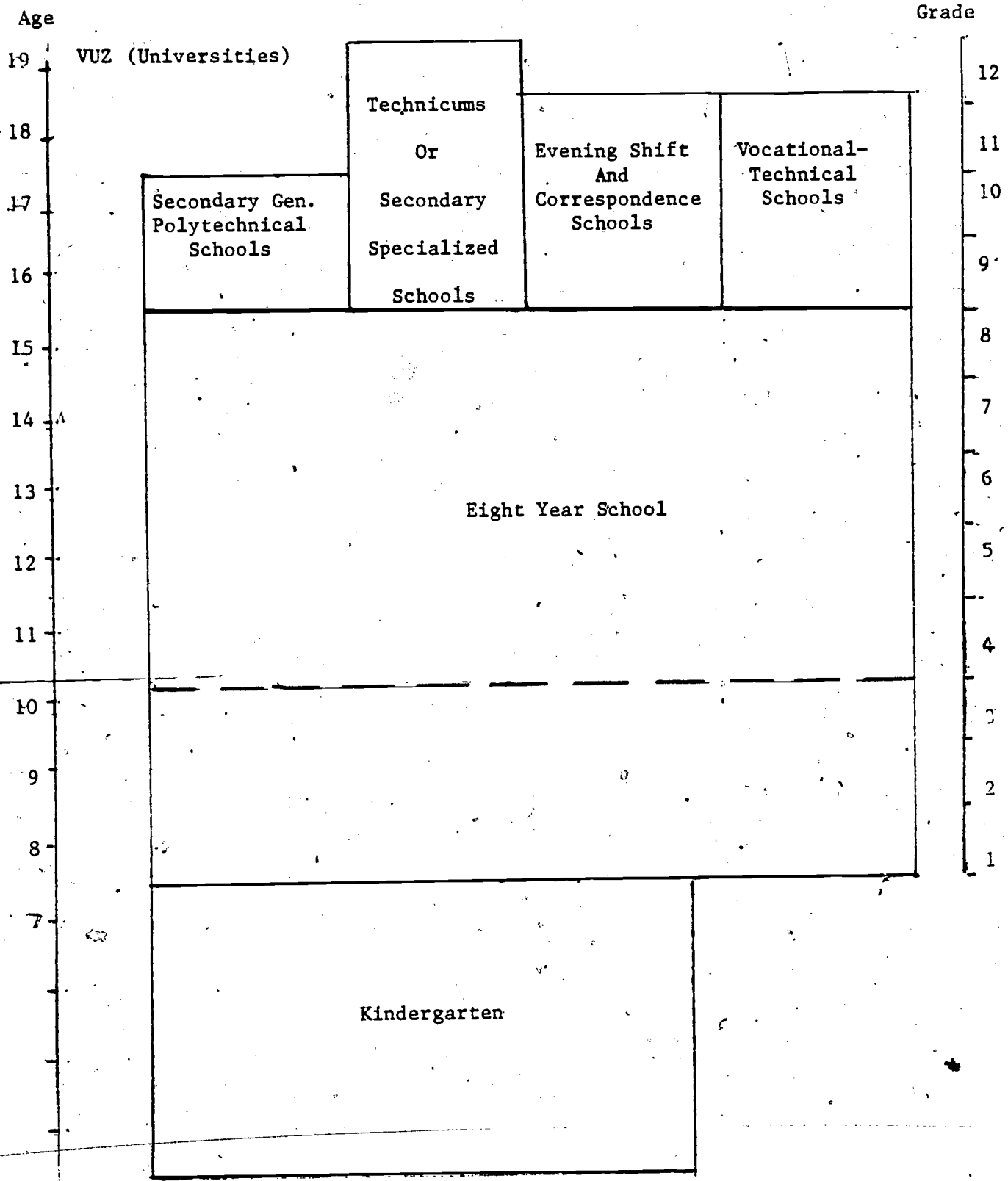
Compulsory graduation examinations are given in Grades VIII and X (XI). Pupils are graded on a numerical system as follows: 5 (excellent), 4 (good),

3 (fair), 2 (poor), and 1 (very poor). Pupils receiving unsatisfactory grades in three or more subjects for the year repeat the same grade.

The total educational system is organized, financed and administered by the State. Public education is reported to be homogenous in structure and continuous at all levels, with uniform curricula and syllabi through the Soviet Union (Shabanowitz, p. 23). Individual differences are recognized through elective courses, extra-curricular activities and specialized schools.

Figure 5: Structure of the School System, U.S.S.R.

24



E. U.S.A.

The school system of the United States exemplifies decentralization. Not only are the several states responsible for policy and practice, they variously delegate responsibilities to districts and school systems within their boundaries. As a general rule, schooling is compulsory from about 6 - 16 years and provided freely to 18 (in some areas to about 20). About 10 per cent attend private schools, the majority of which are associated with a religious denomination.

The predominant pattern is a 6-year primary school, followed by 3 years each of junior and senior high school. In some cases, the two high school levels are contained within one institution. In others, elementary school extends to eight years, followed by a 4-year high school. An emergent pattern is a 4-year primary school, succeeded by four years in each successive level: middle (or intermediate) school, and high school.

Estimates of enrollments in public and private schools at the eighth and twelfth grades are:

	<u>Grade 8</u>		<u>Grade 12</u>	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
Public *	3,273,317	88.9	3,300,447	91.5
Private **	410,389	11.1	304,769	8.5

Teachers are prepared for the elementary and secondary schools in liberal arts undergraduate institutions, the older pattern of teachers colleges having virtually died out. Students follow a general four year course of studies leading to a bachelor's degree, with a concentration in the academic subject they plan to teach (if preparing for secondary school)

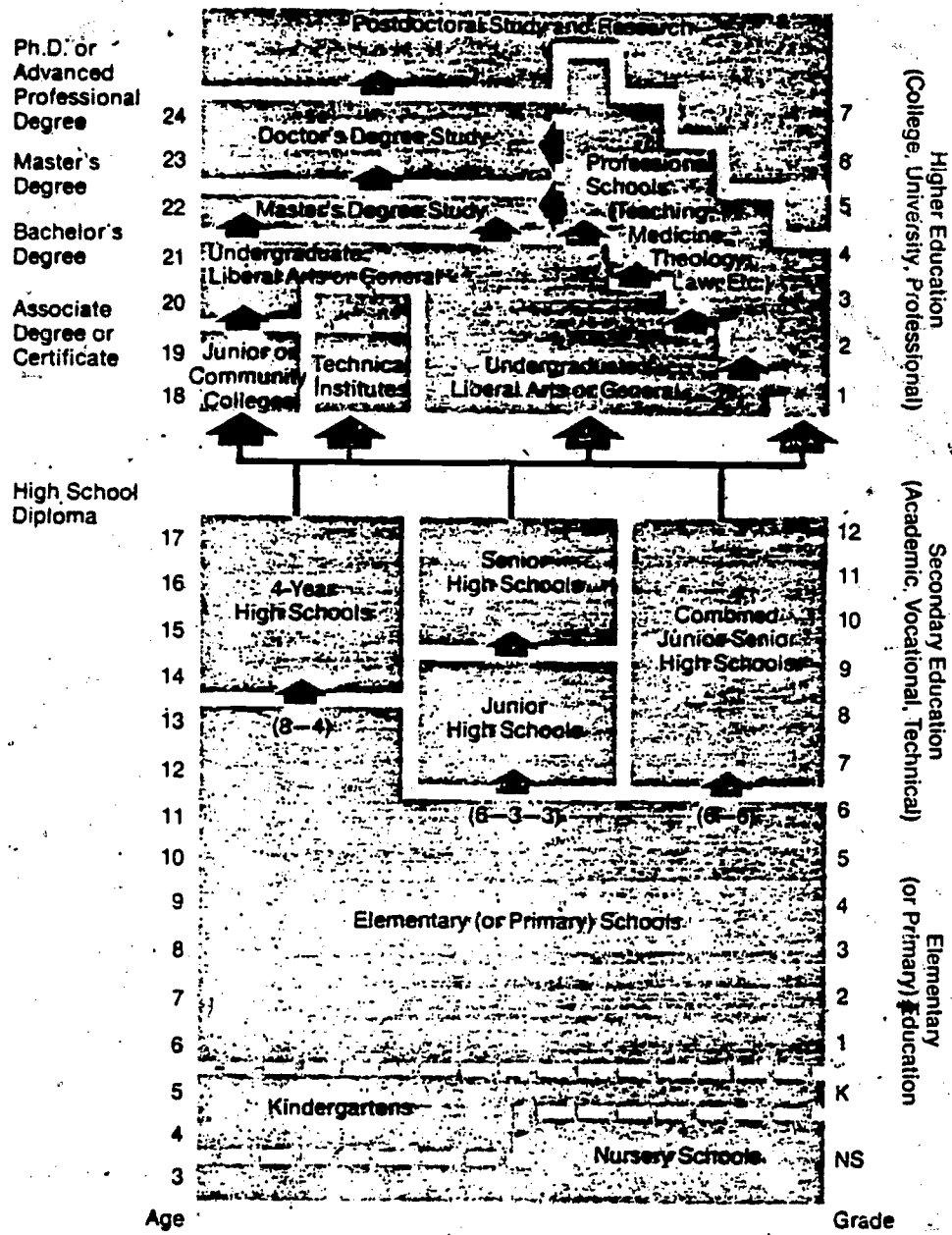
*Source: National Center for Educational Statistics Public School Districts Data Tape, 1979-1980.

**Source: National Center for Educational Statistics Non-Public Elementary/School Survey for 3 Years, (1976-77, 1977-78, 1978-79).

and in professional studies. Some teachers complete the undergraduate program before studying professional subjects at the graduate level. All will have some supervised student teaching experience as part of their professional preparation. Graduate and in-service studies have also been encouraged by salary incentives and State licensing requirements. A master's degree is required for a permanent high school teaching license in many areas.

The only nation-wide examinations for secondary school students are offered by private, non-profit organizations, which determine content and standards of achievement in consultation with teachers, subject specialists and state and local school administrators. Results of such examinations may be taken into account by colleges. Certain authorities provide state-wide examinations for graduating high school students, but students may acquire diplomas signifying completion of a certain number of courses completed as certified by the school authority, which may be sufficient to enter 2- and 4-year colleges.

Figure 6: Structure of the School System: U.S.A.



2.4 The Nature of the Sample of Countries

For the purposes of describing and discussing the curriculum, the following points about the respective national systems should be noted.

The five nations range along a continuum of centralized vs. decentralized systems, from Japan and the U.S.S.R. to Germany, Canada, and the United States. They also vary along a continuum of homogeneous vs. heterogeneous among the regional components of their respective national units. Some nations are more (or less) uniform because of their organizational structures; others more or less uniform because of the ingredients in their national composition.

Apart from the administrative systems, nations differ in the ways they go about determining, disseminating, and changing curriculum content. In all nations, various interests and forces are involved; national and local administrators, university professors (in the subject and in pedagogy), and classroom teachers (through their respective professional organizations). But their respective influence may differ. Periods of active reform in one curriculum area may be followed by periods of consolidation. And changes in the school curriculum may or may not be consonant with changes in the university or college curriculum where prospective teachers are prepared. While teacher training can be described in general terms (number of years, types of institutions and programs), the gap between secondary and college curriculum is unclear, and the time-lag between changes at these respective levels is even more difficult to establish.

3. THE MATHEMATICS CURRICULUM IN FIVE COUNTRIES

3.1 Role of Mathematics in School Curriculum

The study of mathematics is afforded a central place in the curriculums of schools in developing and developed countries alike throughout the world. The importance of the subject reflects the role played by mathematics in contemporary society. At the most basic level, knowledge of mathematics is essential in the conduct of everyday living. More advanced mathematics concepts and techniques are indispensable tools in commerce, engineering, and the natural and social sciences. Thus, from the individual pupil's point of view, the learning of mathematics in schools represents, firstly, a basic preparation for adult life and, secondly, an entree into a vast array of career choices. From the societal perspective, mathematical competence is, firstly, an essential component in the preparation of an informed citizenry; secondly, it is needed to ensure the continued production of the highly skilled personnel required by industry, technology and science, without whom a nation in our modern world is severely handicapped - if not hopelessly crippled.

Beyond these purely practical considerations, it is generally believed that mathematics provides an exemplar of precise, abstract and elegant thought. And whereas the generalized effects of mathematical studies on a student's overall intellectual development are difficult to analyse, let alone measure, there does appear to be a universal consensus that the study of mathematics helps to broaden and hone one's intellectual capabilities.

In view of the importance of mathematics* in society and in the schools,

*Apparently, the American public endorses this view of mathematics. The Eleventh Annual Gallup Poll of the public's attitudes toward the public schools found that mathematics is viewed as essential by more people (97% of those polled) than any other subject. Science ranked fifth out of eleven subjects. Source: Gallup, George H., Phi Delta Kappan, September 1979, reprinted from the NSF Science Educational Databook, 1980, page 69.

30

(see section 2.2), it seems obvious that the efficacy of mathematics teaching and learning deserves sustained scrutiny.

3.2 Case Studies of Mathematics Education

The five sketches which follow are designed to present at a glance the "high points" as they relate to mathematics curricula and instruction in each of the five countries. Three of the countries (Canada: Ontario; Japan; and the U.S.) are taking part in the International Mathematics Study, and therefore, we can provide rather complete information for them. Since mathematics education in the Soviet Union has attracted public attention in the past two or three years, we have a considerable amount of information on the official mathematics programs for that country, as well. We are lacking detailed information on the Federal Republic of Germany. Although there is a rather extensive literature on West German mathematics education,* comparatively little is available in this country in English.

A. Canada: Ontario

The Ministry of Education issues official curriculum guidelines and lists of approved textbooks, films, tapes, kits and other materials. In September 1981, new guidelines for Intermediate (grades 7-10) Mathematics will supersede the guidelines issued in the mid-sixties. Mathematics is a required subject through grade 10. All grade 8 students follow the prescribed

*West Germany has one of the largest and most active research and development institutes in mathematics education in the world, Institute for the Didactics of Mathematics at the University of Bielefeld.

course which consists of core and optional topics. The core topics also have optional sub-topics. No formal tracking or streaming is provided for in grade 8, (in contrast to grades 9 and 10) though the optional topics permit considerable variety from class to class.

At grade 8 the areas of Numerical Methods, Algebra and Geometry contain required topics of Number Applications, Fractions, Ratio, Data Graphs, Integers, Measurement, Circle, Formulae and Equations. There is an emphasis upon Geometric Constructions, Transformations, Plane Figures and Three-Dimensional Geometry.

Optional topics are Rational Numbers in Decimal Form, Relations, Probability, Flow Charts and additional concentration upon Geometry.

Senior Guidelines, issued in 1972, cover grades 11-13. At grades 11 and 12, the mathematics courses offered are Foundations of Mathematics (Advanced level) and Applications of Mathematics (General level). Though not required to do so, virtually all students enrolled in grade 11 take either Foundations (47%) or Applications (48%) courses. Forty-one percent of grade 12 students enroll in the Foundations course and 35% in Applications.

Four grade 13 mathematics courses are offered: Relations and Functions (taken by 65% of students), Calculus (55%), Algebra (28%), and Mathematics of Investment (8%), and students may include all four in the six credits required for Honours graduation. Fifty-five percent of the grade 13 population enroll in two or more grade 13 mathematics courses and approximately twenty percent take three.

Since the Ministry of Education approves all textbooks used in schools and regularly monitors implementation of the guidelines, it exerts considerable influence over course content throughout the Province.



B. Japan

A Course of Study is prescribed by the Ministry of Education and is to be followed by all schools, public and private. A revised Course of Study is presently being implemented: 1980 for elementary schools, 1981 for lower secondary schools, 1982 for upper secondary schools. Mathematics in the upper secondary schools is organized into courses. Students first take General Mathematics or Mathematics I, then Mathematics IIA (non-academic) or Mathematics IIB (academic), then the academic program concludes with Mathematics III. Applied Mathematics is provided for pupils in vocational courses, where students learn advanced topics needed in their specialized areas. The academic series (I, IIB, III) which is completed by about 30% of the students, blends topics from algebra, geometry, analysis, probability and statistics in a series, by integrating them in a coherent system.

Most textbooks are compiled by commercial publishers in accordance with the Course of Study and must pass authorization by the Ministry of Education for school use. Selections among available textbooks is made by local boards of education for public schools, otherwise the selection is made by the school.

The basic framework of the curriculum is outlined in the national Course of Study, a guide compiled by the Ministry of Education. The standard number of school hours (school hour is 50 minutes) devoted to mathematics in the lower secondary school (years seven, eight and nine) is four per week. The school year consists of 35 weeks or more. The content covered during lower secondary school includes number and algebraic expressions; functions, geometric figures; and probability and statistics. The content is the same for all pupils throughout their three years of study. In the Course of Study,



33

however, it is suggested that individual differences should be catered for by differentiating the depth of treatment of the topic.

At the upper secondary school, mathematics is organized not by grades, but according to a sequence of "short courses." A basic course, Mathematics I, is to be taken by all students in the tenth year. The standard pattern for the academic program leads to basic analysis and probability and statistics. Differential and integral calculus are to be studied as a rule after basic analysis. The teaching guide states that, "wherever possible, pupils should be encouraged to use computers or other mechanical aids to computation."

There is also a provision for a "Science-Mathematics" program, leading to specialization in the natural sciences and mathematics. One ingredient is "integrated mathematics," which is studied for thirteen to eighteen hours per week in the eleventh and twelfth years of school. The science-mathematics sequence is to include "actual experience in preparing programs for the computer, running them, and analyzing the results."

An applied mathematics sequence is available, mainly for students in vocation and practical courses. Here they learn advanced topics needed to support specialized topics in their fields of preparation.

Entrance examinations, particularly from upper secondary school to universities, are of a highly competitive nature. Since mathematics is usually a key subject in their examinations, the nature of mathematics teaching in the schools tends to be influenced by these examinations. Tutorial classes in mathematics, which meet outside of regular school hours are available to provide special preparation for the entrance examinations.

C. Federal Republic of Germany

The study of algebra begins in the seventh grade, with amount of contact with science and mathematics increasing through the grades. At the end of 10th grade, all students who have an average of about B or B+ (this varies somewhat state by state) may continue to upper secondary schooling (grades 11 to 13). Others attend vocational school and begin apprenticeships. The students who attend upper secondary school (currently about 28 per cent of the population, up from only 6% ten years ago) declare three major and five minor interests, one of each of which must be a science. Majors are studied for 5 hours a week, minors for 3 hours a week.

At the eleventh grade, algebraic functions and differential calculus are studied. By the end of Grade 13, integral calculus, statistics and probability and vector analysis have been covered. (Based primarily upon lesson plan material and conversations, faculty at the German School, Potomac, Maryland and quoted in Science and Engineering Education for the 1980's and Beyond, (pages 59-60).

The NSF report states: ". . . the overall picture in Germany is one of a very high level of science and mathematics literacy among college graduates as well as a strong science/mathematics understanding among the general population. This provides them with the basic tools to continue their education. (German law guarantees that all people are entitled to a free education to as high a level as they desire) at a later point in their careers, as many choose to do." (NSF, Science and Engineering Education for the 1980's and Beyond, 1980, page 60.)

D. U.S.S.R.

Soviet schools have witnessed a changeover to a new mathematics syllabus within the past few years. Steps have been taken towards raising the standard of mathematics instruction by "making better use of the subject for the pupils' development and general education, by getting away from formalistic learning and by arousing the pupils' interest in mathematics" (Kolyagin et al., 1980, p. 71).

The systematic study of algebra takes place in grades 6-8 (ages 12 through 14 years). Topics dealt with include functions, equalities and inequalities, exponents (integral and rational), polynomials, rational expressions, absolute and relative errors, linear and quadratic equations. The eighth grade program concludes with the introduction of exponential and logarithmic functions and their graphs. Work with the digital computer is also introduced.

At the final stage of the mathematics program (grades 9 through 10) the study of algebra and analysis includes derivatives, integrals and probability theory.

Geometry is studied concurrently with algebra throughout the grades: the systematic study of plane geometry in grades 7 through 8 and a vector based approach to solid geometry, together with the development of an axiomatic approach to geometry in the upper secondary grades.

The identification and nurturing of mathematical talent is an important feature of mathematics education in the USSR. Extracurricular activities, such as clubs and circles and the Olympiads provide one such means. Specialized schools for gifted students in mathematics and the natural sciences have also been developed. For example, a mathematics boarding

school (one of five reported in the USSR) in Moscow is under the sponsorship of the Moscow State University. Closely associated with this boarding school is the noted mathematician A. N. Kolmogorov, who has played a leading role in forming its mathematics program and devotes part of his time to teaching at the school (Shabanowitz 1978, p. 79).

E. U.S.A.*

For roughly the first eight school years (grades K-7, ages 5-12), all students study a general mathematics curriculum, with emphasis on arithmetic of whole numbers, fractions, and measurement. Of course, in many schools students are grouped by ability and move at faster or slower pace through the core topics. The grade/age placement estimates for arithmetic topics 1-12 and mathematics topics 1, 7, 17, 19 and 38 are based on the middle ability range of this general student population. Since there are no published national syllabi, we have based our estimates on scope and sequence outlines of the most common texts, tempered by a dose of practical experience on how those texts are most often used.

Beginning in grade 8 (13 year olds), the first clear content/student streaming appears on a significant scale. Approximately 10% of all eighth graders take a full year course in elementary algebra (polynomials through quadratics). These are the students most clearly probable to enter university study in a mathematically oriented discipline. Their

*This material was prepared for the Curriculum Analysis Group of the Second International Mathematics Study by the U.S. National Mathematics Committee, James T. Fey, Chairman.

normal progression of courses is:

grade 8	(age 13)	Algebra I
grade 9	(age 14)	Geometry
grade 10	(age 15)	Algebra II and Trigonometry
grade 11	(age 16)	Elementary Functions, Analysis or Trig/Analytic Geometry
grade 12	(age 17)	Calculus

(The most common variation is interchange of Geometry and Algebra II. By grade 12 this group has shrunk to about 5% of the student cohort.)

While ability grouping among the remaining mathematics students is common in grades 7 or 8, the next point of curricular streaming is at grade 9 (age 14). At that point most students who will pursue college preparatory programs begin algebra, while the others continue general mathematics (largely pursuing previously elusive mastery of basic arithmetic skills). The second level of college-intending students includes many who will eventually pursue a mathematically oriented career such as engineering, mathematics teaching or computer science. Those students will follow the above course sequence, one year behind. Another group of college-intending students will pursue only two or three years of this sequence--often with much less depth or breadth in the individual courses. As of 1977, enrollments in the various secondary mathematics courses are as given below. The total enrollments in each school year is about 2-1/2 millions. As of 1977, enrollments in the secondary mathematics courses are as given below.

MATHEMATICS COURSE ENROLLMENTS 1976-77
(In Thousands)

*General Mathematics 9-12	3,172
Elementary Algebra	2,825
Geometry	1,900
Advanced Algebra	1,317
Trigonometry	460
Advanced Mathematics	225
Probability and Statistics	39
Computer Mathematics	153
Calculus	105

(Source: NSF Status Surveys)

The grade/age estimates for content in programs for higher education bound students again reflect a consensus of the most commonly used texts. As such, they are probably optimistic, particularly in the topic areas of trigonometry (increasingly separated from Algebra II into an additional semester) and Probability/Statistics (also often offered as a separate senior semester course and slighted in the Algebra II course, even though the topics appear there often). The estimates of first instruction in a topic are also probably optimistic with respect to the students who are least adept in mathematics. For instance, their courses commonly involve much less proof and the Algebra II course is much more limited in scope and depth than that offered to the more capable students.

3.3. Comparative Analysis of Selected Mathematical Topics

Information concerning the mathematical content of the curriculum has been obtained using a survey instrument first developed by the Organization for European Economic Cooperation (OECC) and updated by the Curriculum Analysis Group of the Second IEA International Mathematics Study. The OECC instrument, which was used to help "assess the status of mathematics education in the member countries of the OECC" (New Thinking In School

Mathematics, pp 7-8), provides an overview of the topics which are conventionally accepted as school mathematics.

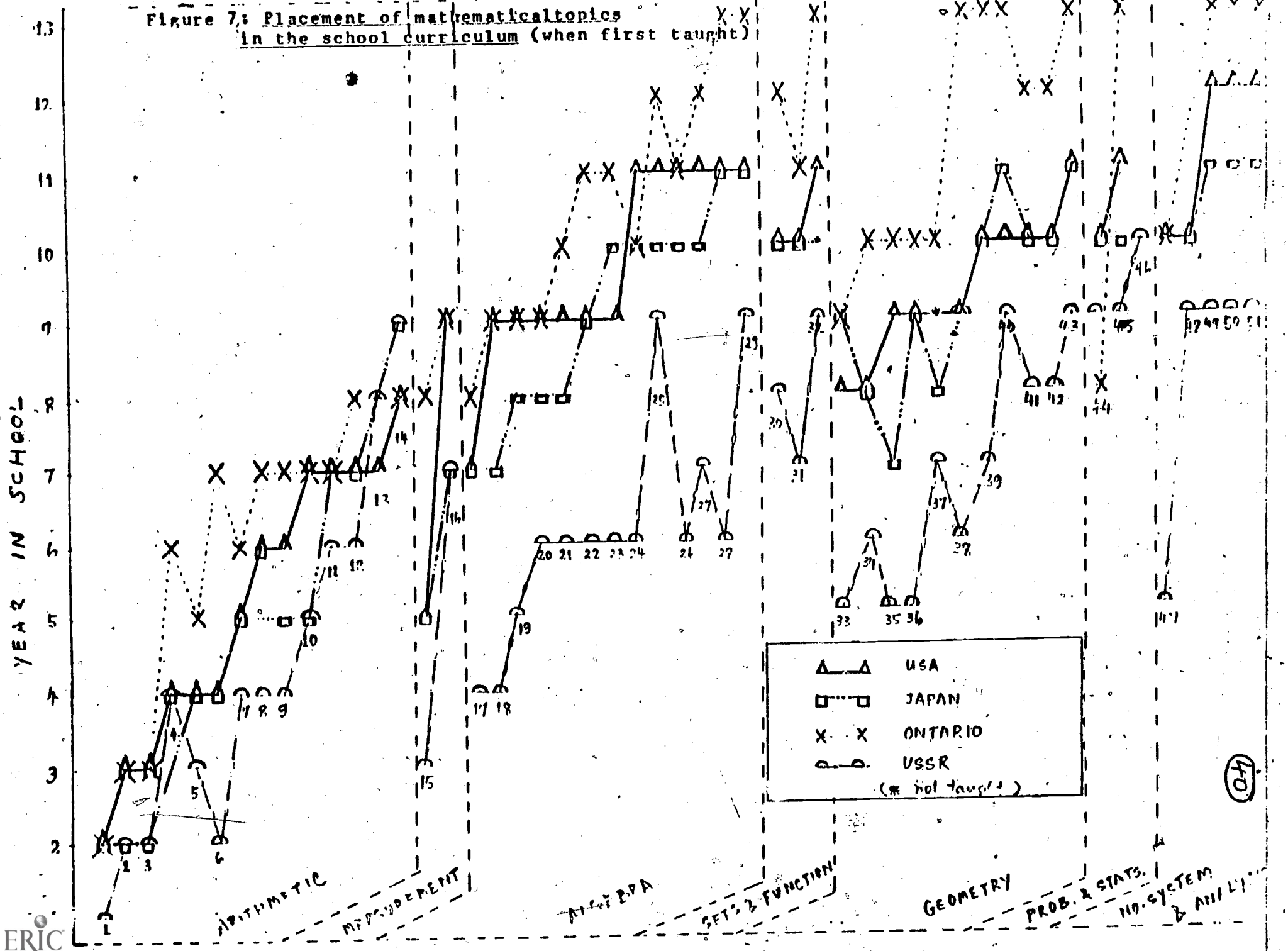
In the IEA Study, National Mathematics Committees in 23 countries (list of countries provided in Appendix A) reported the school year at which each of the indicated topics was introduced. Figure 7, page 40, provides this information for the three IEA countries which are of interest in the present report: Canada - Ontario, Japan and the USA. The data for the USSR have been inferred from Swetz (1978) and Kolyagin, et al (1980). Data from the Federal Republic of Germany are not available at this time.

Figure 7 shows 51 items of subject matter (as indentified in Appendix C) classified according to the usual scheme: arithmetic, measurement, algebra, and so on. For example, we can see that topic 6 (mentally finding the produce 4×239) is introduced in the second grade in the USSR, fourth grade in both Japan and the USA, and the fifth grade in Ontario. In algebra, topic 18, (solution of a linear equation in one variable) is introduced in the USSR in the fourth grade, Japan in the seventh grade, and in the USA and Ontario, in the ninth grade.

It should be noted that the grade placements for the USA are for the typical, and not for the advanced classes. As commented in the abbreviated case study for the USA, approximately 10% of the students take introductory algebra in grade eight, geometry in grade 9 and advanced algebra in grade 10.

Some overall observations about the introductions of topics in the curriculum can be made. Generally speaking, the USSR introduces early, Japan next, then the USA, then Ontario. In Ontario, the content of the curriculum seems to be "spread out" over the thirteen grades of school. Hence, the pace of teaching seems to be faster in the USSR and Japan and slower in Ontario, with the USA somewhat between Japan and Ontario.

Figure 7: Placement of mathematical topics in the school curriculum (when first taught)



The organization of subject matter in the curriculum seems to follow the classification of arithmetic, algebra, geometry for the USA. Moving from left to right, we see pretty much of a "step function" for the USA which increases rather systematically up through the grades. In the high school, we have in the USA the pattern of algebra, geometry, algebra. In the USSR, and to a lesser extent in Japan and Ontario, we see that algebra and geometry are introduced more in parallel through the grades.

The place of calculus in the curriculum of the four countries is clearly shown. For the USSR, it first appears in grade nine, in Japan in grade eleven, in the USA (again, for "typical" rather than advanced students) in grade twelve and in Canada (Ontario) in grade thirteen.

The table, "Availability of High Mathematics Topics in Secondary Schools" was obtained from an item in the survey questionnaire which was designed to help determine the extent to which new topics had entered the curriculum during the 1960's and 1970's. The column headed "Total" refers to the number of countries (out of the 23 responding to the questionnaire, plus the USSR, for a maximum of 24 countries) reporting the given topic to be available at some point in their school mathematics curriculum. For example, matrices appear in the curriculums of 20 of the 24 countries.



TABLE 2
 AVAILABILITY OF HIGHER MATHEMATICS
 TOPICS IN SECONDARY SCHOOLS

0 means not taught
 + means available.

	Canada - ONT	FRG	Japan	United States	USSR*	TOTAL
1. Group Theory	+		+	+	+	14
2. Rings and Fields	+		0	+	+	9
3. Vector Spaces	+		0	+	+	11
4. Matrices	+		+	+	+	20
5. Formal Logic	+		0	+	+	11
6. Boolean Algebra or Automata Theory	+		0	0	+	5
7. Combinatorial Mathematics	+		+	+	+	15
8. Computer Science	+		+	+	+	12
9. Iterative Methods or Algorithms	+		+	+	+	10
10. Linear Programming	+		+	+	+	12
11. Descriptive Geometry	0		+	0	+	5
12. Cosmography, Astronomy, or Spherical Geometry	0		0	0	0	0
13. Non-Euclidean Geometry	0		0	0	+	0
14. Topology	0		0	0	+	7
15. Probability Theory	+		+	+	+	21
16. Statistics (to inference)	+		+	+	+	19
17. Numerical Estimation or Theory of Errors	0		+	+	+	6
18. Formal Treatment of Limits and Continuity	+		0	+	+	14

*Although USSR did not take part in survey, information was added from
 Shebanowitz (1978) and Kolyagin et al (1980).

3.4 Some Noteworthy Programs and Practices

A. Curriculum Revisions -- Geometry - Canada: Ontario

There has been a great deal of curriculum development activity in Ontario during the past decade. The current round of reform will not be fully implemented until 1985. A major focus of this effort has been that of geometry. At the high school level, the program evolves from experiential approaches, moves through inductive reasoning and culminates in deductive proofs. The following topics are included in the program:

Constructions: introduced in Grade 7; a variety of methods using different materials is suggested.

Transformations: introduced as mappings in Grade 7, used as basis for classification of plane figures; glide reflections and isometrics established in Grade 10.

Coordinate geometry: coordinates introduced in grade 7; line graphs introduced in statistics in grade 8. Properties of plane figures using coordinate systems explored in grade 10. Matrices as a special case of transformations studied in Senior grades.

Vectors: applied to force and navigation problems in Grade 10; prepare students for use in physics in grade 11.

Deductive geometry: use of either traditional Euclidean or transformational approach or composite.

Three dimensional geometry: real life objects are examined and related to geometric three dimensional figures.

(Source: Ontario Ministry of Education. Mathematics: Curriculum Guidelines for the Intermediate Division. 1980)

44

The use of the calculator is also encouraged through the secondary program.

As the curriculum guide states:

Teachers should explore and evaluate ways of using calculators . . . for investigation . . . topics in the curriculum, such as investigating number patterns, evaluating algebraic expressions (several dozen activities are suggested). "When used in such contexts, calculators can provide students with motivation and new insights into the curriculum" (pages 11-12).

B. Computers and Mathematics - Federal Republic of Germany

One of the curricular areas about which information has been received is that of uses of computers in the mathematics classroom. To a large degree, this is because one of the major figures in this field, Arthur Engel, of Frankfurt, West Germany, has course materials on computers and mathematics for the Comprehensive School Mathematics Program, now located in St. Louis. Engel, who has appeared on the programs of several past International Congresses on Mathematics Education, believes that the computer has made conventional mathematics courses obsolete. An article entitled, "Outline of a Problem Oriented, Computer-Oriented and Applications Oriented High School Mathematics Course" (1973) indicates his approach to mathematics which is based upon "dynamic models (in mathematics which describe a changing world." The Engel course, written for senior high school, features uses of graphs, algorithms, and simulations, and provides examples for demography, sociology, microbiology and astronomy.

A paper by Winkelman and others (1980) points to the increased availability of micro-computers in schools and to curriculum experiments

throughout the Republic. A course in Berlin, for example, has been drafted which deals with algorithms, data structures, model building and discussions about computer-oriented vocations. The Federal State of Bavaria experimented with a computer course in 1979-1980 and introduced into the mathematics curriculum at the 10th grade level a "computer option" for a course which was intended to "enable students to solve suitable problems by means of developing an algorithm which must be translated into a program and run on a computer" (Winkelman, page 6).

Since the other option for the teachers was descriptive geometry, it would be interesting, indeed, to find out how many actually chose the computer course to teach.

C. Quality of Teacher-Student Transactions - Japan

The Japanese educational system would appear to be one of the most effective in the world. In the First IEA Mathematics Study in 1964, Japan did very well in terms of mathematics achievement at both population levels (thirteen year olds and final year in secondary school). Indications are that this level performance will be repeated on the Second Mathematics Study, as well.*

It is impressive enough that Japanese students appear to have a command of "the mechanics" of mathematics -- calculation, factoring and other lower level skills. But this facility spans the behavioral levels. Japanese children, it would appear, not only come up with the correct answers to problems, but seem to understand what they are doing.

*The interim national report for Japan was released in late 1981 (in Japanese) by the National Institute for Educational Research, Tokyo.



Professor John Easley* of the Committee on Culture and Cognition at the University of Illinois, spent six months in 1981 on a case study of mathematics teaching in first grade classrooms in Tokyo as well as devoting many hours to conversing with teachers and mathematics educators in that country. Easley concludes that much of the success of Japanese mathematics education is due to a commitment to dialogue in the classroom. "Whether or not one plus one equals two," he reports, "is secondary to developing the habits of thought and work needed to become independent learners." This is accomplished through careful control of the conversations over specific problems presented by the teacher rather than by an emphasis on memorization of 'the basics.' Easley's data include contrasting methods from a low income and a higher income area school. In the later (which is something of a demonstration school), Easley says: "we rarely saw a student make a mistake, whereas learning from your mistakes was the chief method advocated by teachers of 1-6 grades in the low income school." (Personal Communication). The classroom is a very productive place in Japan, as Cummings (1977) concludes after a four year study of schooling in that country.

D. "New Math" in the USSR

Mathematics education has undergone a vigorous and extensive period of development in the USSR in recent years. An extensive literature documenting this effort is available, much of it in English. (See, for

*Easley was co-author, with Robert E. Stake of the University of Illinois, of the National Science Foundation's Case Studies in Science Education, 1978



example, the English translations of Soviet research in mathematics education by Wirszup and Romberg.). An analysis of mathematics education in the USSR has recently been done by Davis, et al (1979). Wirszup (1979) has reviewed the Soviet curriculum in a letter to the National Science Foundation. This review received attention in leading U. S. newspapers as well as in the Manchester Guardian and the London Times.

The development of the new Soviet Curriculum began under the direction of the world famous mathematician A. N. Kolmogorov in 1966 and was completed in 1977. As an in-depth review by Keitel of West Germany points out, this curriculum has "not been perfect." For example, Moiseeva (1978) reviewed the results of Union-wide examinations and produced a review of particular weaknesses in the curriculum.

An article by faculty members at the Moscow Regional Pedagogical Institute has leveled attacks on the new curriculum. Kolyagin et al (1980) have made the following comments on the programs:

1. Syllabuses and textbooks contain too much material. The result is that not all of the pupils are able to acquire a full and firm grasp of the mathematics course in the lesson time available.
2. Wrong methods are used in some sections of the mathematics textbooks, since some of the material--especially that which concerns geometry, algebra and analytical principals--is set out in language that totally fails to take into consideration the pupils level of maturity.
3. Poor use is made of problems and exercises . . . the selection of problems is sometimes inadequate for a clear and lasting

understanding of the theory.

- 4. There is not sufficient continuity and integration between the syllabuses and textbooks for the various courses and grade levels (e.g., between the mathematics course for the fourth and fifth grades and the geometry course for the sixth to eighth grades. (pp. 71-71).

Perhaps the most impressive feature of the Soviet curriculum, as noted by Wirszup, is the density of the curriculum. (A ten year program through calculus is required of all students.). Again, as Keitel notes, it is important to obtain background information on the reports from the USSR. For example, she wonders "what Soviet students in fact learn in comparison to what they are expected to learn." (p.6). (In terms of the present paper, we are lacking data on the correspondence between the intended and implemented curriculum.)

The Davis et al review points to a feature of Soviet education which bears further study, as well. He notes that schools are formal, academic places (p.9), while at the same time warm, caring, even loving (p.7). "The familiar U.S. problem of seeing demanding courses in Euclidean geometry or English losing out in the competition with more 'exciting' (and less demanding) courses in film-making, shop, the lyrics of rock music or television viewing cannot occur in Soviet school." (p.9) This is not because Soviet children are deprived of opportunities for activities and special interest projects, but, he claims, because such less formal aspects of education take place in a different structure, the Pioneer Palace.

"Regular" school takes place in the morning and early afternoon. In late afternoon, nearly all children attend this quite different institu-

49

tion, the Pioneer Palace, which is somewhat like a YMCA/YWCA, museum, zoo, Boy Scouts and Girl Scouts, piano lessons, ballet lessons, and so on, all rolled into one. This duality of institutions, school and Pioneer Palace, provides, Davis believes, "a rich learning environment while at the same time freeing the school to place a priority on serious academic subjects."

3.5 Issues in Mathematics Education in the U.S.A.

A. Background Curricular Studies in the U.S.

Several efforts were undertaken in the mid and later 1970's to provide guidelines for directions in mathematics curriculum for the U.S.

National Advisory Committee on Mathematical Education (NACOME) Report

This committee, appointed by the Conference Board of the Mathematical Science, and supported by the National Science Foundation, prepared an overview and analysis of mathematical education in U. S. Schools--its objectives, current practices and attainments. The committee was appointed in 1974 and published its report in 1975. The report, which contains many recommendations concerning policy and research and development, has served as a very useful resource for subsequent investigations and for mathematics educators at federal, state and local levels.

Three National Surveys of Mathematics Education

These studies, commissioned by the National Science Foundation, were carried out in the mid-1970's in order to assess the status of mathematics education and to provide indications as to where improvements might best be found. First, a comprehensive critical review of the literature on curriculum, instruction and evaluation was carried out (Suydam, Marilyn and Alan Osborne, 1977). Second, surveys concerning various aspects of mathematics education were directed at teachers, administrators, parents and students in grade K-12 (Weiss, Iris. 1978). Third, a series of case

50

studies was conducted in selected schools by various educators using a variety of observational and analytic approaches (Stake, Robert E. and John Easley, 1978).

Priorities in School Mathematics (PRISM)

The National Council of Teachers of Mathematics, with funding from the National Science Foundation, undertook a systematic assessment project as a preparation for recommending curricular directions for the 1980's. This project, called Priorities in School Mathematics (PRISM), had two components. A preference study required respondents to identify levels of preferences for various content topics, instructional goals and teaching resources for nine major content strands in the school mathematics curriculum. A priority study sought information on relative importance attached to curricular alternatives and identifying points in the curriculum where change was most needed.

The groups surveyed included classroom teachers at all levels, administrators, curriculum supervisors, school board members and parents.

Agenda for Action: Recommendations for School Mathematics of the 1980's

The National Council of Teachers of Mathematics formulated eight recommendations, based primarily upon the previously mentioned surveys, the National Assessment of Educational Progress data on mathematics achievement. These recommendations were:

1. problem solving be the focus of school mathematics in the 1980's;
2. basic skills in mathematics be defined to encompass more than computational facility;
3. mathematics programs take full advantage of the power of calculators and computers at all grade levels;

- 51
4. stringent standards of both effectiveness and efficiency be applied to the teaching of mathematics;
 5. the success of mathematics programs and student learning be evaluated by a wider range of measures than conventional testing;
 6. more mathematics study be required for all students and a flexible curriculum with a greater range of options be designed to accommodate the diverse needs of the student population;
 7. mathematics teachers demand of themselves and their colleagues a high level of professionalism;
 8. public support for mathematics instruction be raised to a level commensurate with the importance of mathematical understanding to individuals and society.

B. Does More Mean Worse?

All of the countries have a commitment to compulsory education for all students. Some countries have made dramatic moves in this direction only recently (within the past decade). To what extent is such a move compatible with a commitment to excellence in mathematics education? An important finding from the First IEA Mathematics Study was that the scores for the upper four percent of the students in all of the countries, in spite of their wide diversity in retentivity rates, were rather comparable. (From Husen, 1967, Vol. II, page 122).

The Japanese case is instructive here. Rising rates of school attendance in that country have been a national tradition since the beginning of the 20th Century (see data on enrollments in high school mathematics courses in Section 3.5.C.). Rates at universities and colleges have seen corresponding increases. As Kawaguchi notes (1980), "These

trends appear to reflect some correlation between popular belief in the importance of school education and popular awareness of a growth in economic development."

The trend of increased proportion of youth in school has not been without problems, however. Kawaguchi continues: "Inevitably, . . . such sharply increasing attendance rates have introduced many low achievers into the higher levels of education, and the question of how to educate them suitably has become a severe social problem." (page 48).

C. Holding Power of Mathematics Programs

One gets the impression from the other countries that a large proportion of pupils continue their study of mathematics through most if not all of their high school careers. Japan, for example, reports the following proportions of students in academic and non-academic mathematics courses in the upper secondary school (Kawaguchi, p. 49). The academic courses are those leading to college and university study

	<u>Academic</u>	<u>Non-Academic</u>
Grade 10	98%	2%
Grade 11	50%	35%
Grade 12	30%	---

In Canada (Ontario), the following proportions of students are reported in mathematics classes:



<u>Age</u>	<u>Year in School</u>	<u>Percent Enrolled</u>
14	Grade 9	100
15	Grade 10	100
16	Grade 11 Foundations (Advanced)	47%
	Applications (General)	48%
17	Grade 12 Foundations	41%
	Applications	35%
18	Grade 13 Relations and Functions	65
	Calculus	55
	Algebra	28
	Investment	8

55% of Grade 13 students take 2 or more mathematics courses
 20% take three Grade 13 mathematics courses

(Source: National Case Study, Canada (Ontario), prepared for Second IEA Mathematics Study by Ontario Mathematics Committee, Ontario Institute for Studies in Education, Toronto, 1981).

The applications courses are for general education and do not lead to university or college study of mathematics.

USSR*

<u>Age</u>	<u>Year in School</u>	<u>Percent Enrolled</u>
14	Grade 8	100
15	Grade 9 Secondary General	
16	Grade 10 and Specialized Schools	70-75

This compares with the following data on U.S. 17 year olds. The "holding power" of mathematics in the U.S. appears weak.



Figure 8: Percent of 17-year-olds who had taken various mathematics courses , by sex, 1977-78

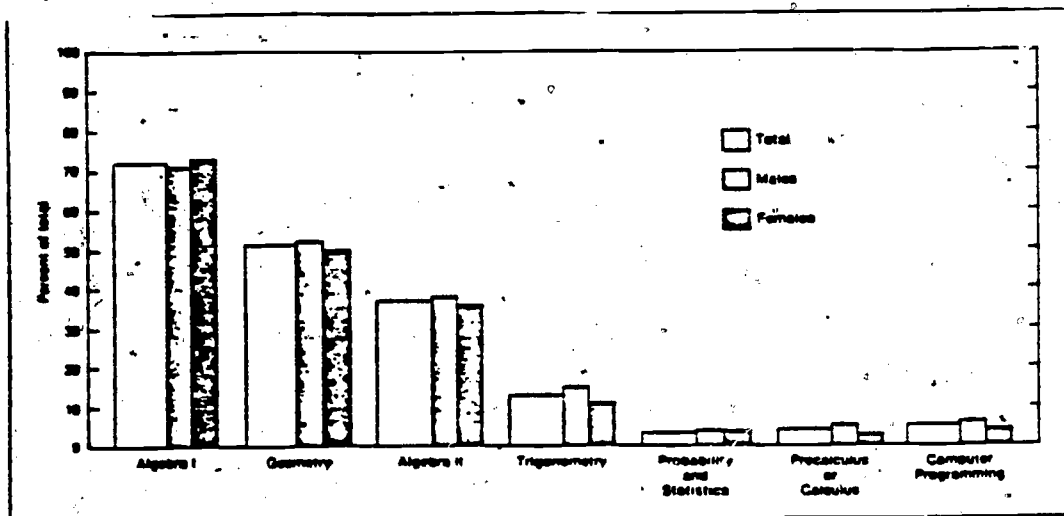
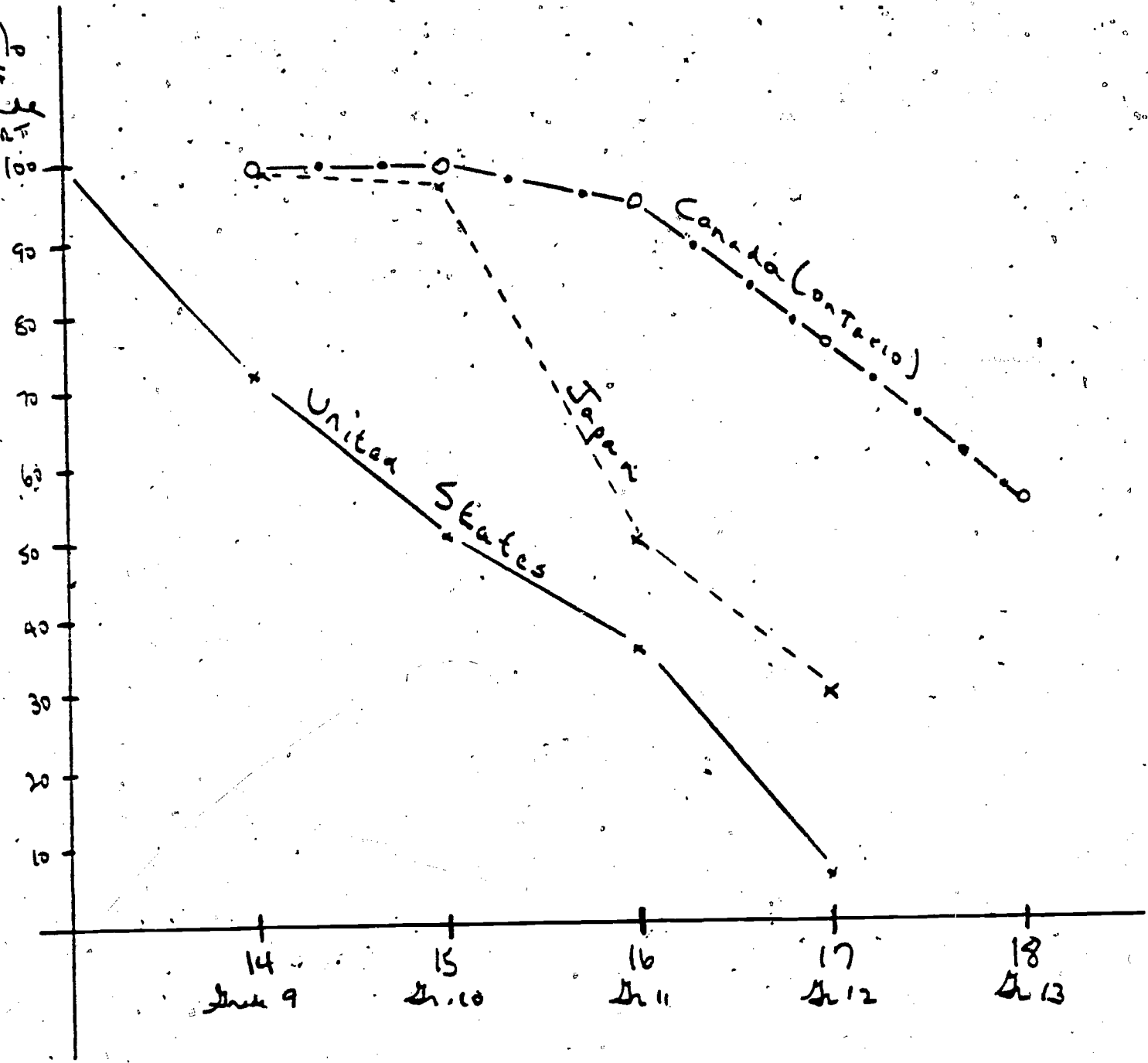


Table 3: Percent of 17-year-olds who had taken various mathematics courses*, by sex, 1977-78

	Algebra I	Geometry	Algebra II	Trigonometry	Probability & Statistics	Precalculus or Calculus	Computer Programming
Total	72.1	51.3	38.9	12.9	2.7	3.9	5.0
Males	78.7	52.1	37.9	14.7	3.2	4.7	5.9
Females	73.9	50.5	38.1	11.1	2.2	3.1	4.1

*Data are difficult to obtain. One source (Dewitt, 1980) indicates about 60% of Soviet students complete General Secondary School and about 12% complete specialized secondary schools.

Fig. 9: Per Cent of Grade Cohort Enrolled
in Mathematics Courses



The data do not reflect the high importance that Americans are reported as having toward the study of mathematics. The decline in enrollment in mathematics courses does seem to correspond, however, with reported declines in attitudes which American youth have towards mathematics as a school subject.

Fig. 10: Percentages of students naming various subjects in school as their most favorite, ages 9, 13, and 17.

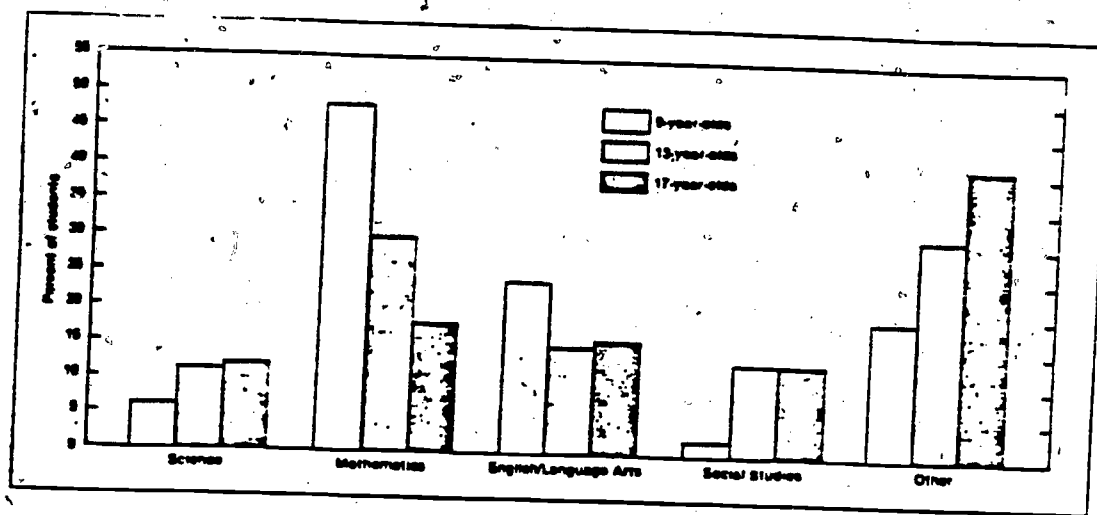


Table 10-4: Percentages of students naming various subjects in school as their most favorite, ages 9, 13 and 17

	Percent Naming Favorite Subject		
	Age 9	Age 13	Age 17
Science	8	11	12
Mathematics	48	30	16
English/language arts	24	16	16
Social studies	3	13	13
Other	10	31	41

Source: National Assessment of Educational Progress, Attitudes Toward Schools, 1984

A critical factor in holding power of mathematics is surely that of requirements for high school graduation and university entrance. As Fey has noted, a survey of school districts in the U.S. in the late 1970's found that over 56% of the responding districts indicated that only one or no mathematics course is required for high school graduation. (1979, page 493).

In the NSF Case Studies in Science Education, senior high school students in a national sample were asked what they considered the one thing most wrong about the mathematics courses they had taken. The following responses were received (N = 318).

	<u>Percent Responding</u>
Courses were boring	31
Courses aimed too much at the 'bright kids'	26
Not enough lab and project work	14
Over-emphasized facts and memorization	13
Courses were impractical	12
Books and Equipment inadequate	5

The seniors were also asked what they considered to be the one thing most right about those mathematics courses. These were the responses (N = 341)

	<u>Percent Responding</u>
(The courses) stressed the basic facts	40
They stressed fundamental ideas	19
Classes have been small	13
Courses were interesting	12
Courses were 'down to earth'	9
Books and equipment were very good	7

D. External Examinations

Japan, USSR and West Germany all require some form of external examination for either high school graduation or university entrance.

An important function of an external examination is to provide a

54

"licensing" or "legitimizing" to a program of study. A pass or honors grade is recognized as attesting to a certain level of competence in mathematics which is (or assumed to be) widely understood and recognized. (For example, advanced placement in the U.S.).

Internationally, the problem of evaluating the programs of diverse schools has arisen in dealing with graduates of the dozens of international schools which have sprung up around the world to serve children of persons in the diplomatic corps or in multinational corporations, and so on.

A common leaving qualification for these schools has been provided by an organization called the International Baccalaureate Office (IBO) in Geneva, Switzerland. To qualify for this diploma, called the International Baccalaureate, a candidate must satisfy an examiner in each of the six subjects, as agreed upon by the various committees which carry out the work of the IBO.

The International Baccalaureate program is now accepted for admissions purposes in more than 30 countries. A discussion of the program, and of particular problems associated with mathematics, is in Morgan (1972).

A joint committee of the National Council of Teachers of Mathematics and Mathematical Association of America has recommended programs of study in high schools which provide appropriate preparation for college study.

Reference: Recommendations for preparation of high school students for college mathematics courses. A companion brochure has been prepared for high school students. Mathematics You'll Need for College.

The College Entrance Examination Board is also concerned with the mathematical preparation of high school students for college and has

59

outlined recommendations in terms of competencies and curricular content in a brochure, Preparation for College in the 1980's.

E. The Content of the Curriculum

As early as 1959, the Commission on Mathematics of the College Entrance Examination Board recommended a re-structuring of the secondary school curriculum to respond to developments in the field and the need for a mathematically sophisticated talent pool to meet the demands of the emerging space age. The commission suggested the inclusion of topics from logic, modern algebra, probability and statistics and recommended that plane and solid geometry be integrated into a single course; that trigonometry be merged with advanced algebra, that inequalities be treated as well as equations. The entire curriculum would be unified through the judicious use of the deductive method, the process of searching for patterns and structural concepts (Van der Blij, et al, 1980, pp. 44-45).

Through the curriculum reform efforts of the 1960's, this unification was effected to some extent. However, as Figure 7 suggests and the full scale curriculum analysis of the Second IEA Study clearly shows, the U.S. curriculum is unlike most others in that it retains the structure of introductory algebra, geometry, advanced algebra, trigonometry, and so on. As a result, for example, the serious study of geometry is delayed until the tenth grade whereas in Japan, for example, it begins in grade 7.

Two specific recommendations of U.S. curriculum studies are cited here:

Geometry

"New and imaginative approaches to the geometry in high school, junior high school and elementary school (are recommended). In particular, a high

rethinking of the role geometry should play in the objectives and goals of the mathematics curriculum and its relationship to the rest of the mathematics program would be timely and valuable." (page 146, NACOME Report).

Statistics

(There should be) "Integration of statistical ideas throughout the curriculum at all levels." (page 145, NACOME report).

While it appears that several countries are dealing with geometry in ways which bear closer examination, there is little indication from the IEA Study that other countries (with the possible exception of the United Kingdom) are making much progress in addressing the issue of how to integrate statistical concepts into the curriculum. Both geometry and statistics were raised in the most recent Annual Meeting of the AAAS. Zalman Usiskin, Professor of Mathematics at the University of Chicago, observed:

"The geometry that is taught was appropriate in the time of Euclid, but does not resemble the most important or useful geometry in today's world Statistics is the most prevalent field of applied mathematics, but high school students learn only the mean, median and mode." (Chronicle of Higher Education, January 13, 1982, p. 10).

F. Impact of Computing Technology on the Curriculum

The work of the West Germans in this field appears to warrant especial scrutiny. As the supply of calculators and micro-computers reaches a level which make them commonplace in home and classroom, it is imperative that mathematics educators and others tap the enormous power of this technology in making significant mathematical concepts more accessible and more applicable to students at all levels of ability. Note recommendation 3, Agenda for Action, see 3.5.A above

An international review of the role of the calculator in mathematics has been prepared jointly by the IEA Mathematics Study and the ERIC Center at the Ohio State University (Suydam, 1980).

G. Minimal Mathematical Competencies

The issue of the extent to which students are attaining minimal levels of mathematical competence in order to function effectively in modern society received international attention during the late 1970's. A review of these concerns in 25 countries was prepared as another joint IEA Mathematics Study/ERIC Center Report (Riehs, 1981).

In response to such concerns in the U.S., the National Council of Supervisors of Mathematics prepared a list of ten basic mathematical skills. "Basic skills," states Tobin, "must include more than computation. The present technological society requires daily use of such skills as estimating, problem solving, interpreting data, organizing data, measuring, predicting, and applying mathematics to everyday situations." (1981, p. 124).

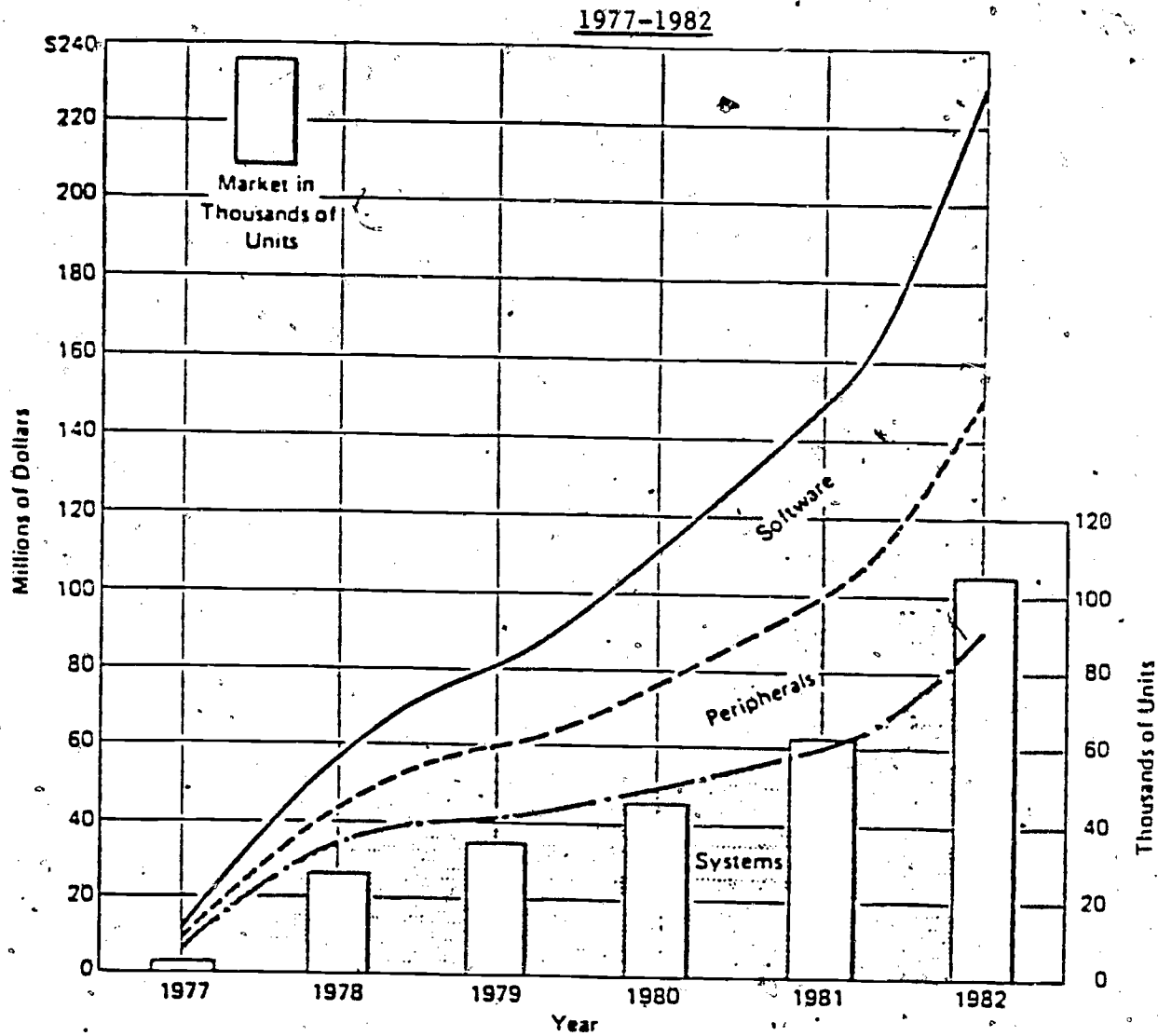
H. Fostering of Talent

Great importance is placed, as a national priority, in the USSR on fostering talent in mathematics and science. Indeed, the Olympiad has been used in the USSR since 1934 as a means for identifying and nurturing talent. Note that the U. S. team of eight high school students won first place in the 1981 International Mathematical Olympiad, beating the second place West German team by two points and third place United Kingdom team by 13 points. (NCTM Newsletter, September 1981).

The holding of annual mathematical contests or olympiads has recently become an important extra-curricular activity in the majority of the

socialist countries. Hungary, which has made many important contributions to mathematics and to mathematics education, was the first country in which school competitions were organized on a national basis. (Skvortsov, 1978, p. 351).

Figure 11: U. S. Personal Computer Market. For Schools



The chart above depicts the growth of personal computer usage since its inception in the mid seventies to the current day, and projects continued future growth of the industry into the next year. It is interesting to note that the market projection for educational software is rising far faster than the market for hardware. As schools purchase personal computers, the need for software increases faster.

4. INTERNATIONAL STUDIES CURRCULUM IN (FIVE) COUNTRIES

4.1 International Studies in the Social Studies Curriculum

As indicated in the discussion above (Section 2.2 above), the social studies curriculum of a nation represents more directly than other subjects the concepts, facts and attitudes that represent the essential nature of a culture. History, geography and civic education, the major common ingredients of the secondary school curriculum, are the subjects that expose students to the facts of their own and other parts of the world. But, with the exception of native language and literature, they are the major vehicles whereby students are taught a sense of their own national identity. This includes facts about the national system, a particular version of national and international events, national political ideology and general cultural knowledge, and the appropriate attitudes towards these.

In any analysis of the social studies curriculum in different countries, therefore, a number of characteristics must be identified. Among them are the political ideology to which the government adheres, prevailing educational theories, socialization practices, and possibilities extant for demonstrating to students the fundamental concepts taught in the social studies classroom. One dimension which is especially important in the postwar years is the intensity with which nationalism should be pursued in social studies classrooms. Today many leaders of government and of education have turned away from any bold preaching of nationalism and instead advocate globalism or internationalism to match our shrinking world.



4.2 Case Studies of the International Component--the Curriculum

A. Canada

The motives for teaching about other nations and cultures extend therefore well beyond the desire for pure information. They may include lessons about hostile or friendly peoples, preferred or rejected social and political behavior, and attractive or distasteful cultural behavior. In the effort to teach the uniqueness of a particular national ethos, the international studies curriculum may express a sense of isolation or one of interdependence with other nations. Whether these are taught, explicitly or implicitly, and the extent to which they occupy a portion of the curriculum, depends upon current and recent political events as well as those of the past. That knowledge about foreign nations is important is unquestionable. Global education, as it is often termed, is a matter of considerable interest to curriculum planners in different nations. But the degree to which all or most secondary school students are supposed to acquire it and the extent to which political, economic or other interdependence is to be stressed varies considerably.

B. Japan

The origins of the present curriculum are particularly important to the international content of Japanese secondary social studies. After World War II Japan was under American military occupation. As a part of it, the United States subjected Japan's educational system to a thorough reform. A significant aspect concerned the total renovation of the social studies component of the curriculum. Not only was it considered essential to rid the schools of any indoctrination of children about the superiority of their country but also students would now have to become well acquainted with the citizen's role in democracy,

the form of government which was being erected by the occupation forces in postwar Japan.

The social studies curriculum which was developed paralleled that found in the United States, no doubt due to the several American social studies educators who came to Japan as advisers during the occupation.

Following the American model, the curriculum included Japanese history and geography, taught at a time when all students were still in school. Traditional courses in Shushin, moral education that included civics, ethics, and political ideology, were abandoned, and appropriately amended civic education emphasizing democratic ideas and forms was added to the social studies content.

One other aspect must be noted. While the American educators who helped to shape postwar reforms urged local control over many aspects of education, during the last twenty years the decision-making power has virtually returned to the Japanese Ministry of Education following the governance pattern of prewar times. Local districts may decide which of the textbooks approved by that Ministry they wish to use, and teachers have some freedom to make instructional decisions.

Goals of Social Studies Education. Since the Ministry of Education informs schools across the entire country on the goals of each part of the curriculum, its statements about the goals of social studies education are accepted everywhere. For the lower secondary school, grades 7-9, they center on the student's knowledge about Japan and other parts of the world as well as on the attitudes to be derived therefrom. The goals are:



To have the pupils deepen their understanding of the geography and history of their country from a broad perspective, to acquire the basic education necessary for citizens, and to cultivate the foundations of the qualities necessary for the members of a democratic and peaceful nations and society. (Nagai, 1982, p. 4)

One of the aims which the ministry urges upon lower secondary teachers points to matters beyond Japan's borders:

Teachers should lead students to understand the role of our nation in the world and in international affairs and cultural exchange, and also let them appreciate other nations' culture and traditions, which should lead to a spirit of international cooperation. (U.S. Dept. of Health, Education and Welfare, p. 129)

The course of study for social studies has been subjected to periodic revisions. Changes have just been completed and for the upper secondary level grades 10-12, and are to be implemented this year (1982). The new objectives are "to have the students deepen their understanding and cognizance of society and humankind from a broad perspective, and to cultivate the qualities essential to the able members of a democratic and peaceful nation and society." (Nagai, 1982, p. 5)

Curriculum. The implementation of these goals has been sought through a curriculum which periodically has been altered during the postwar era. Starting out as an integration of geography, history, civics and ethics in 1947, the social studies program in the lower secondary school today consists of geography and history taught concurrently during grades 7 and 8 and civics taught during grade 9, each for 4-5 hours per week. (Becker, 1981; Nagai, 1982; U.S. Dept. of H.E.W., 1975) Moral instruction has become a separate subject taught once a week, an arrangement which is proving to be less than satisfactory in the minds of many teachers

responsible for the class.

In the upper secondary school, which today is attended by 90 per cent of Japan's youth, a course in 'Contemporary Society' is being introduced for tenth graders. Being interdisciplinary, it integrates ethics, politics, and economics. During the 11th and 12th grade the students may choose from among Japanese history, world history, geography, ethics, and politics-economics. Classes generally meet four days a week.

All during the lower and the upper secondary school nearly all Japanese students take English. While the instruction often consists mainly of pattern practice and other rote memory work or imitation of the teacher, gaining some competence in English has an important effect on these students. English, being a world language, means that Japanese students eventually gain access to the literature of science, diplomacy, business, and other fields. They certainly cannot help but recognize that there is a world out there which uses ~~not~~ Japanese but English to conduct its business. Knowing some English at least is likely to reduce any incipient ethnocentrism of a Japanese youth.

Subject Matter. Within the subjects included in the curriculum, the emphasis remains on Japan, although the world beyond its shores is introduced at various points:

In geography, the proportion of Japanese geography to world geography is approximately equal. In history . . . the proportion of Japanese history to world history is about 70/30. The field of civics has social, economic, and political content. Here the pupils learn about family life, social life, economics, and politics, with an emphasis on understanding the Japanese constitution. (Nagai, 1979, p. 50)



Seventh and eighth grade geography starts with the student's home region and moves outward from there to the remainder of Japan and then to the world. History in the lower secondary school begins with the origins of Eastern civilizations going on to Japan's role in the modern world including her economic and political participation.

The joint Japanese/United States Textbook Study team carefully inspected the various textbooks used in social studies classes in Japan (Becker, 1981). Since the Ministry designates which books are acceptable and since teachers are obliged to follow the official course of study of the ministry, there is a tendency to use the textbook as the syllabus. The study team found that geography textbooks for the lower secondary school emphasize physical geography. They do deal with racial differences, but tend to provide an oversimplified picture of race relations without the nuances which characterize this realm in countries like the United States. In regard to the latter, they quite correctly portray this country as vast, although they seem to exaggerate the power of Wall Street and to play down Japan's economic prowess in reaching out to the world. In their history books, Japanese lower secondary students learn a somewhat different version of rising tension among nations in the prewar Far East and Southeast Asia than British or American students receive--provided they are instructed at all about the history of that part of the world during these same years. The accounts of Japan's part in World War II and the dropping of the atomic bombs on Hiroshima and Nagasaki reflects more rationalistic concern than outright guilt. As for the postwar years, there appears

71

to be ". . . an ideological bias that indirectly states Japan's grievances against the U.S. but makes no attempt to do so vis-à-vis the Soviet Union. The latter's throttling of the liberal revolution in Hungary and Czechoslovakia or the support given to Castro's Cuba are not mentioned but America is chided for her involvement in Korea and Viet Nam" (Becker, 1981, p. 38). One more point needs to be noted, namely, that history focuses more on the action of nations, i.e., wars, harsh economic measures, etc., than on the effects of such actions on the people on this globe.

At the upper secondary level the new course on 'Contemporary Society' uses an interdisciplinary approach to help students analyze modern social problems. The various electives for grades 11 and 12 include a look at the world beyond Japan in the world history course and the two geography options. The intent is to place Japan in the context of international relations. In the social studies textbooks, Japan's policy toward Asia is brought up-to-date. When dealing with the past, controversies between the United States and Japan may be understated, and the presentation of United States history understandably has been simplified. Most world history books contract major events and eras in order to convey a modicum of all recorded history. Clearly, Japanese youth do learn from their textbooks that other nations are important and that Japan has had relations of import with many of them for a long time.

Methods of Instruction. Some variation in the instructional process does occur despite the centralized control over education in Japan.

Teachers may develop some materials on their own to use in conjunction with the textbook. They may, of course, also relate their teaching to the immediate environment of their students or to larger events beyond the community. Teachers set their expectations according to the kind of students they have. Should they have students intent on being eventually admitted to one of Japan's top universities, the teachers' standards are very high. They ease up on less able students. Since civics, politics, and economics form a part of the curriculum, teachers do have an opportunity to link what they teach in school with issues before the Japan's Diet or the United States' Congress.

Recent Reforms. As a result of Japan's vastly increasing interest in foreign trade, the nation has been called on by other nations to make a greater contribution toward the welfare of the Third World. At the same time the Western nations have asked Japan to curtail her imports to their countries to ease their economic plight. These conditions have meant that social studies teachers in Japan may easily engage their classes in discussions of international economic and political matters. Japan can no longer describe herself to her youth as a silent witness of 20th century world affairs. The curriculum reforms of the past few years enable social studies teachers to incorporate such discussions into the subjects they teach.

C. Federal Republic of Germany

Curriculum goals, content, and instructional approaches are determined by the Ministry of Education of the province. While centralization and uniformity has been considerable within provinces,

the growing influence of non-governmental groups and of localities has broadened the base of curriculum decision-making in recent decades. Regional curriculum study centers have been developed as have in-service training centers for teachers.

Curriculum: The curriculum in the Hauptschule, the school for the lowest ability track at the secondary level, consists of geography, history, and social studies. The latter is similar to civics in U.S. middle or junior high schools. Students between 11-16 years have a survey of world geography and history of Germany, with some attention to ancient history and other European countries. The attention, if any, given to the history of Asia or Africa depends on the individual teacher's interest and knowledge. The education ministry of each state provides curriculum guidelines for each subject. These are periodically revised.

The curriculum of the Realschule, the middle track, is very similar to that of the Hauptschule, although teachers will set somewhat higher standards for students. A major difference is that teachers will have had more extensive preparation in history, geography, or civics, than those teaching the lower track.

The curriculum of the Gymnasium is more rigorous. World history and geography are included. Modern German history clearly cannot be taught without reference to other nations, not only within Europe but around the world. During grades 12 and 13, politics, economics, and sociology become the foci of the social studies curriculum. Students begin to debate the ideological differences among W. German intellectuals and political parties. While much of the discussion centers on the

Federal Republic, of necessity it extends into foreign relations and international affairs. Germany's eastern sector, estranged behind the Wall, can hardly be ignored, and West Germany's responsibilities in NATO and the European Economic Community are prime topics for discussion and assessment. Regardless of the type of secondary school attended, students will be reminded of West Germany's contemporary links with Israel, and the historical causes of the special connection: Hitler's policies towards the Jews and the Holocaust.

Instructional Materials. The materials available to history and social science teachers go far beyond the textbook. They encompass a variety of periodical literature dealing to varying degrees with areas outside Germany. For example, Wochenschau (despite its name, a monthly newspaper) is published in two versions, one for younger students and another for older students in social studies classes. In 1981, the former included issues on sports and the Olympic Games, and on the Bundeswehr. Earlier issues (1976-80) dealt with Brazil, conflict and peace efforts in the Middle East, the problems of energy in Europe, racism in the U.S.A. and the American Indian. Repeated attention was devoted to the Third World, the Common Market, and the two Germanies. The publication for older students went beyond these themes, including such topics as the right of political asylum in the Federal Republic, the new fascism, eurocommunism, human rights, and German emigration during 1933-45. Ample opportunity exists through these and other materials to direct student attention to international issues and affairs.

After World War II, the occupation forces encouraged the



establishment of agencies outside any ministry of education to develop instructional materials. This was part of the effort to broaden and make more varied materials for the political education of young Germans in "the new democracy." One such agency is the Bundeszentrale für Politische Bildung (Federal Agency for Political Education) in Bonn, which publishes a weekly newspaper, Das Parlament, reviewing the events of the week. A pamphlet entitled Aus Politik und Zeitgeschichte (Of Politics and Current History) accompanies each issue. Here scholars publish thoughtful articles on current affairs. To what extent Gymnasium teachers and students, the major intended audience, actually read these publications is not clear. Their continued publication testifies to the fact that some teachers and students find them of interest.

The same agency also periodically publishes pamphlets on particular subjects or topics studied in the schools. This series, Informationen für Politische Bildung, supplies an historical overview, geographical and economic data, primary source material, and a careful discussion for each special topic. Recent issues have been devoted to: the U.S.S.R., China, the Common Market, the United Kingdom, the Weimar Republic, National Socialism, and Marxism. Informationen is particularly suited to older students who can use it independently as they do individual research in the last years of the Gymnasium.

Class trips. The older students are, the greater the likelihood that a class excursion will take them outside their national boundaries. Older students in the Gymnasium may visit Paris one year and Rome the

next. Others may visit Denmark or West Berlin. Their accompanying teachers prepare students prior to the trip and continue instruction while sightseeing in the foreign setting (West Berlin means a look over the War and a review of the history of World War II and its aftermath).

D. U.S.S.R.

Goals of the Curriculum. The purposes of instruction are clearly defined: to provide the scientific knowledge that will enable students to recognize the laws underlying social and other developments, at home and abroad, to enable students to understand their functions in a society, and, through their work, to ensure that they make an active contribution to consolidating socialism.

Subject-matter. History, geography, and a course in the tenth grade called social study, are the main subjects in which knowledge of the world outside the Soviet Union is purveyed. History is taught for 2 hours per week in grades 4-7, and 3 or 4 hours in grades 8-10. Geography occupies a smaller portion of the weekly timetable of 30 hours (grades 4-7) or 31 or 32 hours for the higher grades: 2 hours per week in grades 5-9 (about 6.6 per cent). "Social Study" comprises 2 hours of the tenth grade timetable. In addition to these required components, some electives may be introduced in the seventh grade (and after) to supplement the program, and these may include the study of international relations.

Geography progresses from regional and national dimensions to world geography, covering the main regions, and beginning with Africa, stressing physical and economic aspects of the subject. History throughout

throughout seeks to develop a world view of social, political, and economic development, and, again moves toward study of the international nature of class struggle, the international role of the proletariat in revolution, and the brotherhood of the oppressed wherever they may be. In grades 7-8, students are taught about social and political events abroad; in grades 9-10, they study "the activity of champions of peace."

The tenth grade social studies course may be regarded as a culmination of previous study. It focuses on the development of international labor and the communist system, the spread of world communism, and Marxist theory. Stress upon the international ties of working people and the common nature of the class struggle is intended to achieve a sense of "proletarian internationalism." This course of study ". . . has been designed to generalize the world view. Knowledge . . . derives from the study of various school disciplines . . ."

(Ogorodnikov, 1981)

Instructional Methods. Soviet classrooms, like those of many other European nations, tend to be rather formal and traditional in their overall instructional approaches. Students are tested on material taught earlier, new material is presented, recitation and rote learning are standard practices, and student knowledge is then tested again. Only in the upper grades have students been encouraged to use their own initiatives in self-study and in classroom discussion and debate concerning the study materials. However, as part curriculum reforms in the last decade or two, student participation has been given greater

attention and educators have encouraged a freer and less formal atmosphere in middle and upper grades. How far this movement has proceeded is difficult to ascertain.

Student Attitudes. Studies of how students rate the several subjects in their school curriculum may be enlightening. According to Men'shchikova (1981), mathematics is clearly preferred to other subjects by both boys and girls in the upper grades (except in certain rural areas where the school system may be least developed). However, while history occupies the fourth place in student ranking of school subjects, social study rates very low. While international study of the proletariat, the communist movement, and Marxist theory of world events comes high in the priorities of curriculum designers and school planners, its social and educational prestige among most students seems low. Undoubtedly, the rank of a subject denotes its significance for higher education and career opportunities.

Extra-curricular Aspects. Special note should be taken of extra-curricular activities which serve as a second, after-school, program. The extensive activities of the youth organizations (the Young Pioneers and the Komsomol) are intended to extend, reinforce and consolidate the school curriculum, and deliberately planned for these purposes. As fourteen and fifteen year olds learn at school about political events abroad, as members of the Pioneer clubs they may attend protest meetings against the exploitation of peoples and collect funds to help them. As older students (grades 9 and 10) engage in political discussion, writing journals, and studying heroes of the revolution at home and abroad, they are encouraged to do ideological work with younger Pioneer members,

teaching them what they have learned and organizing various activities. In all areas of curriculum, youth organizations are the framework within which individual talents and tastes are encouraged to develop, sports and recreational activities are carried on, and where the lessons of international studies are reinforced and extended.

E. U.S.A.

Social Studies Curriculum. In the United States, national and international orientations in the social studies curriculum are clouded by local control over education. Curriculum developers must satisfy those who seek to internationalize the curriculum, those who wish an ethnocentric approach, and those who want to celebrate their own state or community by means of what is taught in social studies.

Today, American history and American government continue to dominate the social studies curriculum in public schools (Superka et al., 1980).

At the secondary level non-national studies, i.e., the history, geography, government, economies, and so on, of areas outside America's borders appear in ninth grade to some extent. Here 'world cultures' are often the subject content. In tenth grade, world history is the most common elective. In some schools it is taken by the more competent students while in others it is a subject reserved unofficially for the non-college bound student. If geography is taught at all, it tends to be at the middle school or junior high school level.

Two trends must be noted. On the one hand, ethnic studies have received more attention, as have other electives which draw on the

Figure 12

Dominant Social Studies Curriculum Organization Pattern
in the U.S.A., by Grade Level

- K—Self, School, Community, Home
- 1—Families
- 2—Neighborhoods
- 3—Communities
- 4—State History, Geographic Regions
- 5—U.S. History
- 6—World Cultures, Western Hemisphere
- 7—World Geography or History
- 8—American History
- 9—Civics or World Cultures
- 10—World History
- 11—American History
- 12—American Government

behavioral sciences. These may or may not lead the student beyond our borders. At the time, the 'back-to-basics' movement has caused a retrenchment in some schools of social studies options offered to students and a renewed emphasis on American history and government. The new History/Social Science State Framework (1981) developed in California recommends that seventh graders be introduced " . . . to the major epochs in the history of humankind in both Western and non-Western worlds, including the significance of contact between nations, societies, and cultures." Grade 8 centers on the American experience and grades 9 and 10 on civics. The latter two grades are also to encompass World Cultures, that is "an in-depth study of selected cultures or culture areas chosen from both the Western and non-Western world." Grades 11 and 12 are to be devoted to the United States, its history, political, economic, social, and legal systems. Comparisons with other nations should be included for clarification (History-Social Science Framework, 1981).

What remains unclear is the extent to which teachers of American history or American government, or economics, include topics which show how the United States has been intertwined in political and economic matters with other nations in the past and present, and will remain so in the foreseeable future.

The International Component and the Goals of Social Studies Education.

The inculcation of the American way of life is generally the first reason stated for the inclusion of social studies in the secondary school curriculum. The terms 'teaching citizenship' or 'teaching the

meaning of our democratic heritage' may also be found. A far less potent reason for social studies for many is the need to introduce students to the social sciences or to decision-making as citizens in our democratic society. The National Council for the Social Studies' recent listing of the Essentials of the Social Studies (1980) begins with the statement, "Citizenship participation in public life is essential to the health of our democratic system. Effective social studies programs help prepare young people who can identify, understand and work to solve the problems that face our increasingly diverse nation and interdependent world." In order to "deal with critical issues and the world as it really is," students should become familiar with the "history and culture of our nation and the world, geography-- physical, political; cultural and economic, government--theories, ~~systems, structures and processes,~~ . . . and worldwide relationships of all sorts between and among nations, races, cultures and institutions." While there is distinct reference to the world beyond America's borders, the remainder of the "Essentials" concentrates on basic concepts of U.S. democracy, on thinking skills and participation skills, and on the role of civic action. When applied, civic action testifies as to how well a person has integrated the other three "essentials."

In the Revision of the NCSS Social Studies Curriculum Guidelines (1979) a further reference to a globally-centered approach is targeted as a goal. The program should include analysis and attempts to formulate potential resolutions of present and controversial global problems such as racism, sexism, world resources, nuclear proliferation, and

ecological imbalance.

The History-Social Science Framework for California Public Schools (1981) begins by drawing attention to our multicultural shrinking globe of which we are a part:

The central purpose of history-social science is to prepare students to be humane, rational, understanding, and participating citizens in a diverse society and in an increasingly interdependent world--students who will preserve and continue to advance progress toward a just society. (p. 3)

In order to attain this goal, educators should liberate history students from either a national or Europe-centered approach to the subject. Rather, global history should present "the development of the civilizations of Europe, Africa, Asia, Australia, and the Americas in a parallel perspective contrasting nations and societies culturally, economically, politically, and psychologically." (Cortes, 1981, p. 16)

If one surveys various recent issues of Social Education, the journal of the National Council for the Social Studies, one also encounters pleas for greater emphasis on global education, on human rights education, and on environmental education. If instituted in a social studies classroom, these may enhance the students' understanding of other people in other parts of the world. Other issues of Social Education have been devoted to one non-Western area or another such as China (January, 1973 and March, 1980), the Middle East (October 1978), and Japan. The Holocaust was the theme of the April 1978 issue; the February 1981 issue featured a long article on the Germans and their Nazi past, and the April 1981 one on "Teaching About Russia and the Soviet Union."

Content. Since American secondary schools concentrate so heavily on the history of this country and its government, the content selected is equally restricted to that subject. America's forays into foreign lands during our several wars are included. The conditions abroad which caused people to immigrate to the New World at various points in history are less fully explained. In world history books the content usually focuses on the ancient civilizations of the Middle East, Greece and Rome, Europe during medieval times, the Renaissance, Reformation, and Enlightenment, colonial expansion overseas to the New World as well as Asia and then Africa, the Industrial Revolution and the French Revolution, the Age of Napoleon and of Victoria, the two World Wars, and the era of the United Nations and the East-West confrontation. Brief sections may be devoted to the spread of Islam, to Latin America, to the history of China and Japan, and to Russia's growth. In the most recent editions chapters on the Third World have been added.

In reference to the teaching of world history in American schools, one must note that it is not ethnocentric. For much of the time no mention is made of the United States. In England, France, or West Germany, by way of contrast, the earlier rise of Western civilization becomes the history of England, France, or Germany, respectively.

Methods of Instruction. In the 1960's, Project Social Studies consisted of a series of government-sponsored, university-centered curriculum projects which not only introduced new content but also, if not mainly, promulgated new instructional methods. Inquiry, that is having students



looking at many sources in order to arrive inductively at a comprehension of history, government, or society became especially popular. The use of material from the several social sciences formed the basis of some other projects. Students were encouraged to handle materials and inference--and decision-making were encouraged. Games and simulations were devised to replace textbook explanations of social, economic, or political phenomena. The technique of values clarification gained considerable popularity although the teacher did not necessarily follow up a student's designated value choice by a thorough analysis of the presumed consequences of that choice to himself/herself or to the larger community. As Kohlberg developed his strategies for assessing moral growth, teachers also tried their hands at these techniques.

The effect of Project Social Studies appears to have been temporary. While a number of teachers tried one or another of the projects or the ideas contained therein, in due time they reverted to using the textbook as their primary source of information and student classroom activities (Shaver et al., 1979). In some cases the materials to be used in conjunction with one of the projects were too costly for a school district. In another case, the inquiry approach led to open discussion of aspects of the society which a community or some of the parents did not wish to have discussed in social studies classrooms. The Back-to-Basics movement also pushed for a strictly controlled curriculum, a requirement which could be more readily fulfilled if the teacher relied on a textbook as the syllabus. While inquiry, values



clarification, moral education, and decision-making may easily lead a class to realms beyond our borders, a textbook-centered approach will only do so to the extent that the content of that book introduces that world.

The Teachers. In the United States teachers of social studies appear to be of two kinds. There are the groups who majored in history or one of the social sciences. These have a deep interest in their subject matter and often attempt to supplement it by further study as they remain in the profession over the years. Among them are a few who actually majored in non-western studies or in the subject of geography. In addition to these teachers, there are those in many schools who came to the school to coach a particular boys' sport. They may have majored in physical education in college. They may have something close to a social studies minor by virtue of the general education component of their four year undergraduate program. These, too, are assigned to teach the social studies. Their knowledge of non-Western areas, of geography, or of Europe is likely to be sketchy. They generally lack a sufficient base in history or a social science to go on to do any graduate work in one or the other.

Teachers of social studies do expand their knowledge of the world by travel. In a recent survey of such teachers the researcher found that nearly 80% of the social studies teachers surveyed traveled outside the United States at least once, and four out of ten visited other countries at least three times:

Canada is the favorite destination (61.3%), with Latin America second (34%). About 26% have visited Western Europe, but Africa and Asia are not on the typical social studies teacher's itinerary. North Africa, Southwest Asia, and Southeast Asia have been visited by less than 5% of the respondents. (Risinger, 1981)

Among the last group are veterans of Viet Nam and social studies teachers who have participated in summer programs in India, Japan, and Israel.

Relationship to Learning Outside the School. What distinguishes American students from those of other developed countries is their relative political inactivity. Some few take part in election campaigns, but seldom does a high school student witness first hand the deliberations of a political party. During the Viet Nam era, however, as well as during the Civil Rights movement and similar drives, such as the one against the use of nuclear energy, they have been able to participate in street demonstrations for causes which have an international dimension. Seldom do high school students engage in political theorizing, perhaps because of the heavy emphasis in schools on the democratic ideology. Any systematic distillation or analysis of Marxism is presented only at the college level in the United States.

As for any direct experience abroad, such opportunities exist for the children of military personnel, of other government officials who are assigned abroad, and of employees of multinational corporations who are assigned to overseas locations. Other high school youth may have an exchange student in their high school or may themselves become



one in a foreign country.

Innovations. Global education appears today to have caught the imagination of some American teachers of the social studies.. One of its proponents, M. Eugene Gillion defines it as " . . . those educational efforts designed to cultivate in young people a global perspective and to develop in them the knowledge, skills, and attitudes needed to live effectively in a world possessing limited natural resources and characterized by ethnic diversity, cultural pluralism, and increasing interdependence." (Gillion, 1981, p. 170) Through global education students are to recognize the differences among nations as well as the similarities, particularly our common charge to share this earth with one another. An NCSS Position Statement (1975) on Global Education goes further:

World affairs have often been treated as a spectator sport in which only the "expert" can participate. The increasing globalization of the human condition has created additional opportunities and responsibilities for the individuals and groups to take personal, social, and political action in the international arena. The curriculum should demonstrate that individuals and groups can influence and can be influenced by world events. Furthermore, the social studies curriculum should help to develop the understandings, skills, and attitudes needed to respond effectively and responsibly to world events.

Whether or not human rights education should be considered a part of global education is unimportant. What does matter is that the subject is another aspect in the social studies which has attracted the attention of social studies teachers. A number are interested in Amnesty International and its work of identifying political prisoners

89

in various countries. Other teachers have a deep commitment to teach their students about the Holocaust. Some find that teaching about the Helsinki Agreements and the U.N. Agreements that stipulate what rights all persons are entitled to, a productive way to compare the repression practiced in the Soviet Union with the civil rights which Americans feel to be constitutionally theirs. In a recent circular distributed by the New York State Education Department (1981), Justice Around the World are announced.

A third area of interest remains future studies. Here individual teachers are basically free to attack that issue in any way they wish. To what extent their approach is an ethnocentric one is difficult to judge although in most classrooms where future studies is the topic the intense interdependence of the world's peoples is clearly recognized.

4.3 Issues in International and Social Studies in the U.S.A.

In the light of the preceding comparative descriptions, it is clear that international studies occupy varying portions of the secondary students' time at school in the several advanced nations. The content is largely historical and geographical, with some attention to political institutions, ideology, and cultural forms. In the United States, international studies are certainly present as a component in the social studies curriculum, but there is no assurance that students at large are exposed to any particular set of studies. World history is often an optional subject sometimes chosen by the more able students, geography is very limited and sometimes entirely absent from the student's experience, and the study of foreign cultures may amount to no more than a unit of "Strange Lands and Friendly Faces" during the middle or lower grades of schooling. Even college-bound students cannot be presumed to have any particular grounding in knowledge of the world beyond national boundaries. The kind of world outlook that is presented to students may be uniform and very sharply defined in some countries, less specific and more pluralistic in others. To the extent that such a global view is taught, directly or indirectly in the United States, it is highly variable across the nation.

The reasons for the heterogeneity are quite clear. School districts and even individual schools may make selections within state curricula. They are responsive not merely to the wishes and the knowledge of teachers but also to the sensibilities of parents and political or other interest groups. Moreover, international studies must vie for time in the school program with other, sometimes quite new components: legal

studies, drug and alcohol abuse, consumer and environmental education, law, moral education. Some components offer added opportunity to engage students in the acquisition of knowledge of the larger world (for instance, economics, anthropology, ethnic studies). However, they do not help to develop unity or consistency, or integrate knowledge in order to develop some world view (or views). Some districts and schools offer various forms of international studies as described above but others some give no more than a passing glance at the rest of the world in a required American history course.

As the Gallup poll cited above (Section 2.2) indicates, foreign languages and material on foreign relations rank very low in the public view of what is essential to the high school curriculum. It is difficult to conceive of ways in which this perception might be changed. Professionals in the field and many social studies teachers do not need to be persuaded (see, for example, Smith and Cox, 1969; National Commission on Secondary Education, 1973). However, many involved in determining curriculum policy and practices in the secondary schools are unwilling or unable to achieve consensus in the matter in the relatively open market where numerous and varied public interests compete. Nor can this issue be separated from the heterogeneity of kinds and levels of knowledge expected of social studies teachers. This variety, and the range of different attitudes of American teachers in respect of international or global education, is not simply a function of the college preparation of prospective teachers, it is part of the nation's perceptions of itself and the world. American social studies teachers differ greatly in what they know and what they teach. As to the esteem attached to the



international studies component, there is little reason to suppose that those who design the secondary school timetable differ substantially in their views from the public at large.

5. CONCLUDING OBSERVATIONS

5.1 On Comparative Curriculum Study

Aristotle's instructions to the poet could well be applied to the comparative educator studying curriculum: to imitate (or describe) one of three objects--things as they were or are, things as they are said or believed to be, or things as they ought to be. This paper has focussed largely on the second object on the assumption that this effort may inform consideration of the third.

As a rule, official curricula ("things as they are said to be") state their objectives by identifying cognitive learning objectives. They may include general statements of educational goals--references to developing each individual's capacities to the full, and educating for political, social and economic participation--, statements that appear rather similar from nation to nation. Less frequently does the curriculum define non-cognitive objectives and the real priorities between societal and individual goals. Even after close scrutiny of particular elements in the syllabi of given subjects, it remains difficult to evaluate curricula with respect to their objectives, an important step on the way to prescribing "things as they ought to be."

Countries differ in what they exclude and what they include in the secondary curriculum at various levels. Despite similarities among the more developed countries, differences occur in how subjects are arranged: sequencing, relative emphasis, and the integration of one part with another. According to Holmes (1981), some countries draw their principles of inclusion and exclusion from the disciplinary characteristics of knowledge (he cites France and England as examples); others make such decisions



9.4

based on a view of society--their own and a global vision--which expresses their own political and economic aspirations. The examples given are the U.S.S.R. and the U.S.A. It seems clear that Holmes' observation applies to the former nation; it may be that the exclusions and the inconsistencies in the U.S. curriculum are in fact a function of the changes and uncertainties in world outlook of that nation.

5.2 On the Mathematics and International Studies Curriculum

One general conclusion to be drawn from the comparison of the mathematics curriculum, in addition to the particular issues addressed in Section 3, is that proportionately fewer students in the United States are exposed to mathematics at lesser levels of difficulty and for less time in secondary schooling. This is despite the fact that the best of the mathematics curriculum is presented to many students, that some of them in some schools are able to reach relatively advanced levels, that considerable professional effort goes to review and improve curricula, and that mathematics is widely regarded as important in the academic and the broader community. While the problem may lie in part with the specifics of curriculum, it is suggested that it is rooted in those philosophical and organizational approaches that continue to shape American educational practice.

From studying foreign systems of secondary education, we observe that on the whole, and not unpredictably, the more important differences educationally are between those nations that are more selective and those that are more comprehensive. Similarly, those countries that require their students to specialize at the upper secondary level stand out from those that lean toward a more general (and comprehensive) education. The United States has long been committed to the latter alternatives, and has deliberately sought to identify and begin to prepare specialists in

mathematics or any other subject at the secondary level. It has attempted to implement minimum standards of education for all and to establish normative criteria for the many. Judgements about curriculum (whether as it is supposed to be or as it actually is) must consider all three objectives.

Other developed nations of the world, on the other hand, have all in some degree sought to move toward the comprehensive ideal, while retaining a firm grasp on their traditional practices of selection and variously early specialization. They too are conscious of the need to improve mathematics teaching and learning for mathematics specialists and for non-specialists, for high level abilities and for improving numeracy in the population at large.

The preliminary conclusion from surveying the international studies component is that American secondary school students receive no more than a modicum of instruction in this area, though some will receive more than others. Students in other countries, if they remain at school in the upper grades and particularly if they are bound for college, are likely to receive more extensive grounding. In the U.S., the major context for international studies is world history. Ethnic studies or world cultures may in some instances provide additional settings. Geographical studies however appear to be very limited. Scope, emphases, and approaches in other countries are different. In Japan, both domestic and international political and economic issues serve as a focus for study, as they do in Germany. In Germany, too, historical and current relations with the European nations particularly, create a bridge to studies of foreign nations. Attention to the physical and other aspects of geography sustains



it. The U.S.S.R. exemplifies a nation with a clearly defined, single approach to world studies, an approach grounded in a clearly articulated political theory and intended to achieve a particular unified world view.

For the European nations in general, national history emerges from the rise of Western civilization in the context of earlier European history. In the United States, the emergence of the newly independent nation at the end of the eighteenth century is not only a new chapter but is often presented as a new beginning, independent of its European origins.

In the U.S., curriculum in both mathematics and social studies has been subjected to various pressures to change, not the least of which were the Federal initiatives from the late 1950's on. The intent has been to upgrade and improve and one implication has been towards some degree of standardization, especially in science and mathematics. The concerns appear to have been normative in the first instance. More recently the trend seems to be concerned with establishing minima (as represented in moves towards basic competency). Attention needs to be given to the implications for high quality teaching and learning--for excellence.

5.3 On Teachers and Instruction

Our study provides no evidence that teachers are passive conduits of a uniform and inflexible body of information and skills in any of the nations reviewed, nor that they are being replaced by computers or other instructional aids. On the other hand, it is not evident that teachers given up on traditional didactic practices to assume the role of "animateur," though examples may be found in each country of individualized and independent study, discovery methods, and the like.

What the paper does confirm, is that in all countries the curriculum is subject to change from time to time, that teachers are intensively involved in curriculum review and revision, and that examples of specific ideas and practices are certainly instructive, and may serve as benchmarks.

Though the patterns are neither clear nor consistent, most foreign countries appear to be making efforts to diversify and to integrate the elements of their curricula, especially in the social studies area, and to give increasing attention to comprehension rather than to mere mechanical acquisition of information. Again, especially in the social studies curriculum, and that part dealing with international or global education, there is a problem of articulating the secondary curriculum and the course of studies for prospective teachers. Inservice education assumes even greater importance at times of curriculum change.

5.4 On the Processes of Curriculum Change and Policy Making

To compare curricula is an exercise in the study of comparative cultures. Though they are beyond the scope of this report, a number of considerations are most relevant. We have not considered the historical dimension: the growth of knowledge in general, and the extent to which curricula have been affected by the pressures to add topics and even new subjects to the secondary education of increasing proportions of a nation's youth. We have not looked at the curriculum as a whole or raised fundamental questions of educational purposes and processes, without which the place, the content, and the form of any particular subject area cannot fully be assessed. Nor has it been possible to survey the whole curriculum in a given subject, that is, as a sequence of teaching activities throughout the school system (from the early grades through the college years) and in the real world of the family, the

community, and the society where the mass media serve as influential forms of mass education. The information and attitudes purveyed by television and the press may be the most persuasive sources of 'knowledge' in the international studies curriculum to which secondary students are exposed.

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105

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106

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APPENDIX A

Second IEA International Mathematics Study Participating Countries

- Australia
- Belgium (Flemish)
- Belgium (French)
- Canada (British Columbia)
- Canada (Ontario)
- Chile
- England
- Finland
- France
- Hong Kong
- Hungary
- Ireland
- Israel
- Ivory Coast
- Japan
- Luxembourg
- Netherlands
- New Zealand
- Nigeria
- Scotland
- Swaziland
- Sweden
- Thailand
- USA



APPENDIX B

Hours Reported Spent on Mathematics Homework Per Week (1964)

	<u>Grade 8</u>		<u>Grade 12</u>	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Canada - Ontario	-	-	-	-
Federal Republic of Germany	3.4	1.9	5.1	2.9
Japan	3.0	1.8	5.2	4.3
USA	3.1	2.5	4.1	2.4
USSR	-	-	-	-

(Source: Husén, p. 187)

Hours Per Week of Mathematics Instruction (1964)

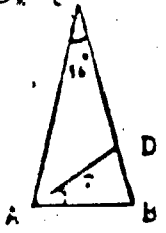
	<u>Grade 8</u>		<u>Grade 12</u>	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Canada - Ontario	-	-	-	-
Federal Republic of Germany			4.2	.5
Japan			5.5	1.1
USA			5.0	.9
USSR				

(Source: Husén, p. 185)

1. $66 + 25$
2. $804 - 347$
3. The multiplication tables to 10×10 or beyond
4.
$$\begin{array}{r} 784.92 + \\ 27.38 \\ 63.67 \\ \hline 591.59 \end{array}$$
5. 684×342
6. Find mentally (use no paper and pencil): 4×239
7. $2\frac{3}{5} + 5\frac{7}{12}$
8. $2\frac{3}{4} \div 1\frac{5}{8}$
9. 375.24 divided by 17.3
10. What is the number of which $15\% = 6$?
11. Find the greatest common divisor of 42 and 5610 .
12. $12^2 \rightarrow 6^3$
13. 37 is expressed in decimal notation. Rewrite it in a system to base 6 .
14. Find by estimating, the decade in which $\sqrt{600}$ lies.
15. Calculate the area of a triangle given a base of 8 cm. and an altitude of 5 cm.
16. Find the volume of a pyramid, the base of which is 16 sq. cm. and the height 12 cm.
17. $(+10) - (-25)$
18. Solve $3x - 7 = 2x + 4$
19. Plot the graph for:
 $y = 3x + 2$
20. Solve the inequation
 $3x + 2 > 8$
21. Solve $3x - y = 5$
 $x + 2y = 11$
22. Solve $3x^2 - 15x + 18 = 0$
23. Two trains each cover a run of 960 km. The one train takes 4 hrs. longer and averages 20 km. per hour less than the other. Find the rate of each train.
24. Solve the system: $y > \frac{1}{2}x - 1$
 $y < 3 - \frac{1}{3}x$
 $x > 0$
25. Solve and discuss the solutions for the various values of m :
 $(m - 1)x^2 + (2m + 1)x + (m - 2) = 0$
26. Determine the roots of $3x^5 - 7x^2 = 0$
27. Plot the graph for:
 $y = \frac{3x + 5}{4x - 5}$
28. Expand $(3x - 2y)^8$
29. Prove $1 + 4 + 9 + \dots + n^2 = \frac{1}{6}(2n + 1)(n + 1)(n)$ using mathematical induction.
32. Show for all sets A and B that $A = (A \cap B) \cup (A \cap B')$
30. f and g are functions such that $f(x) = x^2 + 1$ and $g(x) = x - 2$. If $a = f(1)$, find $g(a)$
31. Draw the graph of $y = |x| - 2$ for the interval $-5 \leq x \leq 5$

Note: $|x|$ denotes absolute value of x .

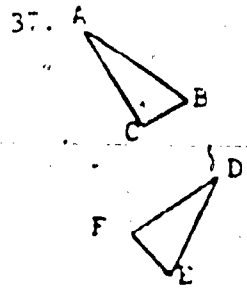
35. $\overline{CA} \cong \overline{CB}$ and $\overline{AB} \cong \overline{AD}$
 if $m\angle ACD = 30^\circ$, find $m\angle BAD$



33. Calculate the side of a right angled triangle given that the other side is 5 units and the hypotenuse is 7 units

36. State and prove the Pythagorean Theorem

34. Find the equation of the straight line determined by the points
 $A = (3, 2)$ and $B = (4, 1)$



Find the center of the rotation that maps $\triangle ABC$ onto $\triangle DEF$.

38. Prove: If a straight line is perpendicular to each of two intersecting lines, it is perpendicular to the plane of these two lines.

39. Find the center and radius of the circle whose equation is
 $x^2 + y^2 - 4x + 2y - 4 = 0$

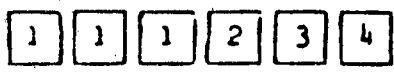
43. Given two free non-zero vectors \overline{AB} and \overline{CD}
- i) find $\overline{AB} + \overline{CD}$
 - ii) find the scalar product $\overline{AB} \times \overline{CD}$

40. Complete and prove for any angles α and β
 $\cos(\alpha - \beta) =$

41. Derive the law of cosines for any triangle.

42. Find the period of
 $y = 2.6 \sin \frac{\pi t}{60}$

45. How many different linear arrangements can be made with the following cards?



44. What is the probability of getting at least 3 heads in a throw of 5 coins?

46. Assuming a normal distribution with give mean and standard deviation, what is the probability in a sample of 10 of getting at least two individuals with a deviatric of 2 or more standard deviations?

47. Assuming the associative, commutative, and distributive and cancellation laws, and the properties of 1 and 0, prove for the domain of positive and negative real numbers that
 $(-x)(-y) = xy$

48. Write $\frac{1}{2i + 3}$ in the form $a + bi$.

49. Find the derivative of the function
 $y = 3x^2 - 5x$

50. Find the maximum and minimum values of
 $y = x^3 - 12x + 5$

51. Find $\int_1^2 (x^3 - 4x + 3) dx$