

School Organization and Time Allotted to Mathematics Study.

Objekttyp: **Chapter**

Zeitschrift: **L'Enseignement Mathématique**

Band (Jahr): **5 (1959)**

Heft 1: **L'ENSEIGNEMENT MATHÉMATIQUE**

PDF erstellt am: **21.07.2024**

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algebra. He can make simple deductions, but his entire concept of proof, if any, is limited to that of theorems in geometry. He really does not know what mathematics is, or how it is applied, but he has a large body of information, upon which, if he is inclined or interested, a study of mathematics can be built in the ages 16 years to 21 years. The whole program, the world over, is overloaded with "doing" and it would appear that a reformation of this program with emphasis on "reasoning" and an elimination of much useless and extraneous busy work could enliven the subject and leave the 15 year old with a much clearer and stronger picture of what mathematics study really is.

SCHOOL ORGANIZATION AND TIME ALLOTTED TO MATHEMATICS STUDY.

One thing is certain, and that is that the school organization and selection of students is unique in each of the countries having compulsory (and free) education. The starting age for grade 1, or first year of formal schooling varies from 5 years to 7 years of age. Thus by the age of 15 years, youth in the several countries have had from 8 to 10 years of schooling. But the number of years of instruction is modified somewhat by the fact that the number of clock-hours of instruction per week, and the number of weeks per year vary greatly from country to country. Thus the total allotted time for mathematics instruction compared with the entire instructional time in a given country varies from 20% to 9%. Statistics are boring, so here follow a few sample programs and time allotments that are indicative of the highest, lowest, and median of the countries reporting.

In all countries, the first four years of instruction is given in an elementary or folk-school, which all children regardless of ability or social origin may attend. The classes are taught by a teacher who teaches all subjects, that is, there is no special teacher for mathematics or the other branches of learning. The only exception to this statement is the use of special teachers

fort art and music in these four grades. Evidently most countries assume that art and music are special talents that all teachers cannot learn to teach, but that this is not the case with language, mathematics, and history.

All countries continue the general elementary education under one teacher up to the end of the sixth, seventh, or eighth grades. However, in many cases there is a splitting of those who "can" from those who "cannot" into separate schools and separate programs beginning at the fifth, sixth or seventh school year. Only two countries, Canada and the U.S.A., maintain a common school throughout the first eight years of study. There is quite a general agreement on compulsory education of all children for 8 years, but this is not strictly adhered to. The trend is to increase the number of years of required attendance at school. In all countries mathematics is a required subject of instruction throughout these 8 years. Where the capable pupils are separated into special schools, mathematics study for these pupils is required every year up to the age of 15 years (and beyond).

In Russia, formal schooling begins at age 7. During the first seven years of schooling (up to the age of 15 years), there are 6 lessons in mathematics every week for 33 weeks of the year. That is 198 lessons per year and this comprises 20% of all the teaching time. During the first five years all the work is on arithmetic; during the sixth year, 2 lessons each on algebra, geometry and arithmetic, and during the seventh year, 2 lessons on geometry, 4 on algebra. During the first four years one teacher gives all the instruction, after grade four all teaching is done by specialists. The instruction in all seven years is compulsory for all students with no separation into special classes.

In France, the elementary school begins at age 6 and runs for 5 years. During the first three years $3\frac{3}{4}$ hours per week are devoted to the study of mathematics which is 12% of the total teaching time. During the 4th and 5th years, the time is increased to 5 hours per week or $16\frac{2}{3}\%$ of the teaching time. However, in the next four years, where the students study in separate classes according to ability and future aims, the weekly

study of mathematics is reduced to $2\frac{1}{2}$ hours, soon to be increased to 3 hours or only 10% of the teaching time.

In the German schools, for the first 9 years of study of those entering the Mittelschule or Gymnasium, mathematics instruction takes 15% of the teaching time, and this same percent applies to the countries Norway, England, and Sweden. In Japan, since the reorganization of its schools after the war, there is a six year common elementary school and during the first four years only 10% of the teaching time is given to mathematics. This is increased slightly during the fifth and sixth year, and there is a trend to increase the amount of time given to the study of mathematics. Generally it appears reasonable to say that mathematics instruction of youth up to the age of 15 years occupies about one-seventh of all the teaching time, and that this ratio does not increase, rather it decreases as youth continue studying beyond age 15, unless they go into specialized study of science. How few do this will be shown later.

When pupils leave the common elementary school to go to special schools to take special courses such as are offered in the gymnasium, Realskole, Grammar School, High School — College Preparatory Course and the like, they must be assigned either by directive or by choice. In most cases the selection is made by results of examinations, in which an examination in mathematics is an important part. The other areas examined are usually the national language and history. The examination is usually written, but in some cases, consists also of an added oral examination. Some typical examples are the following: In Finland, at the end of the fourth grade, all pupils seeking admission to the secondary school sit for an examination. Recently about one-half of all school children took this examination; 73% of these passed the examination, but due to lack of space only 60% of these were admitted. Hence, beginning at grade 5 (age 11-12) only 30% of the youth of Finland have a possibility of professional careers. What part of this 30% succeed on getting to college is hard to say, but by comparison with other countries certainly at the very most $\frac{1}{4}$ or about 7% of all the youth.

In England, a similar examination procedure is necessary to enter the Grammar school and takes place at age 11 years. The percent of all the pupils passing the examinations varies throughout the country but averages about 20%. In Scotland this examination is postponed to age 12 years. In India, where the curriculum is very advanced, there is an examination every year for passing to the next grade. About 50% fail these examinations every year, and these examinations are now regarded as the worst feature of their educational system. Similarly France, Germany and Denmark have entrance examinations at a very early age (10 or 11 years) for admission to the schools preparing for University attendance. Norway has an examination at the end of the seventh school year, and Jugoslavia at the end of the eighth school year. In France, selection is made at the end of the 5th school year, by the use of the pupils' previous marks, but the pupil may apply to take a written examination if his grades do not permit his selection. In the Netherlands, there is an informal examination in mathematics at the end of each year in which about 10% fail and must repeat the year's work. But at the end of the sixth year there is a very severe examination and only a very small percent of the total school population (less than 15%) is admitted to the Gymnasium or Higher Burgher School.

Only Canada and the U.S.A. have no selective examinations. However, at the end of grade eight or nine, the pupils are advised to take programs adapted to their inherent abilities, and their probable life work when they finish school, but it must be stressed that the choice made is voluntary on the part of the pupil and his family.

The segregation of pupils at too early an age must be looked upon with some grave reservations as to its consequence in this day and age. No matter what is said about transfer, it is the universal rule, that *once ruled out*, a pupil rarely has opportunity to cross to the better track. During the ages of 11 to 14 years, boys and girls are undergoing physical changes that have real psychological implications. It would appear that a choice at age 14 years would be far more significant of real ability and opportunity than at age 11. In Germany, and the

same would hold for many other countries, about 25% of fifth grade students enter the Gymnasium, but only $\frac{1}{4}$ of these eventually finish the full 9 years. Of those completing the *Arbitur*, only 30% are in the Scientific line and this means that about 2 out of every 100 pupils completing grade 5, study a program in mathematics throughout the next 9 years so as to enter a University to major in mathematics or science. In this day and age, this is too small a number for the needs of our society. Perhaps the grave shortage of mathematicians and teachers of mathematics, may in some measure be traced to too highly rigid selective processes *at too early an age*.

THE TEACHERS OF MATHEMATICS.

In all countries, a shortage of teachers of mathematics is occurring and in many countries it has reached a critical state. There is bound to be a relaxing of certification qualifications in the years immediately ahead, so that any report on teachers of mathematics must be based on stated requirements rather than those actually achieved. Generally teachers of grades 1 to 4, and in the elementary school from grades 4 on to 7, 8, or 9, have graduated from a secondary school in the academic, that is college preparatory line, and have attended a teacher training college or pedagogical academy for a period of from two to four years. They have had courses in teaching arithmetic, but have studied very little or no mathematics after entering their teacher training program.

Teachers in the program from grades 5 to 8 (or 9) may have been trained in teacher colleges, but in addition have also continued their education in special subjects and taken examinations in these subjects before being certified. Teachers above the eighth year of study are University graduates with a major or minor in mathematics. They are specialists in their field. In general, the training of teachers of mathematics as specialists in instruction for the fifth to the tenth grades in European countries, includes the study of far more mathematics, than in Canada or the U.S.A.