I. Pre-University Education

The Italian school system is centrally governed by the Ministero della Pubblica Istruzione. Education is compulsory between 6 and 14 years of age, i.e., grades 1 to 8. It is divided into primary and junior secondary level.

The primary school (scuola elementare) lasts five years (grades 1 to 5).

The junior secondary school, also called middle school, (scuola media) lasts three years (grades 6 to 8).

After grade 8, approximately 80% of the corresponding age group enroll in some kind of upper secondary school. Up to grade 8, there is only one type of school (with mixed ability classes); hence differentiation starts at this moment. The different types of upper secondary schools may be grouped into four categories:

1. lyceums (classical or scientific);
2. technical schools (many options);
3. specific institutes for the training of elementary school teachers;
4. vocational schools (many options).

The lyceums and technical institutes last five years (grades 9 to 13); the institutes for elementary school teachers last four years, while vocational schools may last from a minimum of two to a maximum of five years. At the end of the five year courses and at the end of some of the four year courses, there is a nation-wide final examination, called maturità. The following table shows the most important quantitative data (updated to the year 1990):

<table>
<thead>
<tr>
<th>School type</th>
<th>% of age group enrolling in grade 9</th>
<th>Number of students who passed the maturità in 1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classic lyceum</td>
<td>5</td>
<td>40,000</td>
</tr>
<tr>
<td>Scientific lyceum</td>
<td>12</td>
<td>90,000</td>
</tr>
<tr>
<td>Technical schools</td>
<td>36</td>
<td>170,000</td>
</tr>
<tr>
<td>Elem. teachers inst.</td>
<td>5</td>
<td>40,000</td>
</tr>
<tr>
<td>Vocational schools</td>
<td>22</td>
<td>70,000</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>410,000</td>
</tr>
</tbody>
</table>
With the only exceptions being some vocational schools, mathematics is compulsory for all grades, but the time devoted to the subject is insufficient: for instance, in each of the last three years of the classic lyceum only 2 hours per week and in the scientific lyceum only 3 hours per week (out of a total of 30) are devoted to mathematics.

The syllabi for all school types include algebra, geometry (both Euclidean and Cartesian) and the study of a few standard functions (polynomial, exponential, trigonometric and so on), while calculus is only taught in the scientific lyceum and in some types of technical institutes.

A reform of the upper secondary school system is planned. The main points of the reform will be: two more years of compulsory education (until grade 10), teaching computer science (including practical computer activities) within the mathematics courses and an increase of one or two hours per week in mathematics for all school types. Many upper secondary schools have already adopted new (experimental) curricula and syllabi in accordance with the planned reform. The assessment is usually performed both on the basis of written and oral examinations. The use of multiple-choice tests is not popular at all.

II. Universities

In Italy, universities are centrally governed by the Ministero dell’Università e della Ricerca Scientifica e Tecnologica. The number of universities is growing every year. At present there are about 40 universities and 2 polytechnical schools, i.e., university-level institutions for engineering and architecture. Mathematics degrees are awarded by almost all universities. Computer Science degrees are awarded by an increasing number of universities (10 at present). Engineering degrees are awarded both by the main universities and by the two polytechnical schools.

With few exceptions (medicine and computer science), there is no numerus clausus, nor are there admittance examinations. Every student who obtains any kind of maturità at the end of a five year secondary school is free to enroll in any university. Students who obtain a maturità after a four year secondary school must spend one more year in school before entering the university. Approximately 30% of Italian 19-years olds enroll in the university, but the academic success rate is very low: in most faculties, only 1 student in 3 completes his studies successfully.

Italian universities award two kinds of degrees in mathematics:

1. Laurea (roughly equivalent to a Master’s degree): The studies officially last four years. In practice for most students, they last five years or even more.

2. Dottorato di ricerca (roughly equivalent to a Ph.D). Access is limited and based on selection. To be admitted students must have a laurea in mathematics or in some related field such as physics or computer science. Those who are admitted receive a small grant from the government. The studies last four years after the laurea.
Note: From 1992 on, a third type of degree called Diploma (roughly equivalent to a Bachelor’s degree) will be available. The studies will consist of two years in mathematics and three years in other subjects such as computer science or engineering. Although the curriculum for the diploma shows significant differences with the curriculum for the first years of the corresponding laurea, it will be possible, with some penalties, to continue studying after a diploma to obtain a laurea.

Quantitative data

In Italy, each year approximately 4,000 students enroll for the laurea in matematica but only 1,300 complete their studies successfully. In percentages, these 4,000 students correspond to 0.5% of their age group and the 1,300 students to less than 0.2% of their age group.

The low academic success rate, i.e., the fact that only one student in three reaches graduation, is very unsatisfactory but, as already mentioned, this is not a specific feature of mathematics: 4,000 freshmen in mathematics represent approximately 1.7% of the total number of Italian freshmen in all disciplines, and the 1,300 students who obtain their laurea in mathematics represent approximately 1.7% of the total number of Italian students who obtain their laurea in all disciplines.

It is hoped that the introduction of the diploma will increase significantly the number of students who complete their university studies with a degree—although at a lower level than now—in mathematics as well as in other disciplines.

The figures concerning mathematics have been more or less steady during the last ten years, with a slight tendency to decrease. This fact may be due to a strong increase in the number of students (now nearly 6,000) who enroll each year for the laurea in Informatica (computer science), as well as to a modest increase in the number of students (now nearly 35,000) who enroll each year for a laurea in faculties of Engineering and Architecture. In these faculties, the academic success rate is approximately the same as in mathematics—between 30 and 35%. Each year, approximately 160 students enroll for the Dottorato di ricerca in matematica and 100 complete their studies successfully. Since the Dottorato di ricerca was only introduced 10 years ago, these figures are likely to increase in the next few years.

Organization and curriculum

In order to obtain the laurea in matematica, students must attend a total of 15 whole year courses during the four years of their university studies (4 courses during each of the first three years and 3 courses during the last year). Typically, a course consists of 60 to 70 hours of lectures for large audiences (up to 300 students or even more for some first year courses) and 60 to 70 hours of exercises, practical work, and so on for the same class, usually split into two or three smaller groups.
There is a specific examination at the end of each of these courses. Several courses are in physics. Some whole year courses may be divided into two one semester courses.

At the end of their studies, students must also write and discuss a dissertation (Tesi), which is supposed to contain original results but in most cases remains below the level of a research publication.

The curriculum is, at least formally, the same all over the country and is quite rigid. The laurea in mathematics is split into three branches: “General mathematics”, “Applied mathematics” and “Didactics of mathematics”. Of the 15 courses each student has to attend, 10 are compulsory and are common to all these branches. Typically these are:

3 courses in calculus (including differential equations);
3 courses in geometry (including topology);
1 course in algebra;
3 courses in physics.

Two more courses are compulsory but differ from one branch to another. Therefore, after having enrolled in a specific branch students can only take three one year courses, or equivalently six one semester courses, of their own choice. There are courses in computer science and in numerical calculus for mathematics students in all universities. They are not compulsory, except for those who are enrolled in the “Applied mathematics” branch.

The assessment for most mathematics courses is based both on written and oral examinations, with more emphasis than in other countries on the oral part. This procedure is rather time consuming, but has the advantage that students become accustomed to interact with examining teachers. Also, oral examinations seem more appropriate than written exercises to evaluate the students understanding of theoretical aspects of the matter. Students who fail to pass the examination for a course at their first attempt can try again up to 3 times during the same year.

The curricula for the Dottorato di ricerca are less rigid than those for the laurea. They include courses, workshops and personal research work. At the end of their studies, students must write an original research dissertation.

### III. Teachers Training

Up to now, elementary school teachers completed their training at the secondary level. In the future, in accordance with a new law, there will be a specific university degree for these teachers too, including mathematics and science courses.

The training of secondary school mathematics teachers takes place within universities in the branch “Didactics of mathematics”. Usually, the same teacher also has to teach other subjects such as physics and computer science (in upper secondary schools) or natural sciences (in middle schools). More than 50% of the mathematics students who obtain their laurea in mathematics become secondary
school teachers. Generally speaking, there is no shortage of teachers in Italy. However, the new generations of mathematicians are barely sufficient to ensure the turnover in upper secondary schools, while the majority of those who teach mathematics in Italian middle schools have a degree in natural sciences and not in mathematics.

The training of Italian secondary school teachers is good in the specific topics they have studied at the university, but these topics may not cover all the subjects they have to teach. Moreover, their training lacks pedagogical and sociological aspects.

The Italian university teachers are divided into “Full Professors”, “Associate Professors” and “Research Fellows (Assistant Professors)”. At present, there are approximately 800 mathematicians working in each one of these three categories. This corresponds to about 5% of the total number of Italian academics in all disciplines. Although these figures may seem high with respect to the rather low number of mathematics students, it should be noticed that mathematics professors do not only teach in their own faculty, but also in several others (the main bulk being in engineering and computer science) as specified in paragraph 4. In particular, the number of research fellows is not at all sufficient in order to meet adequately the needs for teaching and research in mathematics. Recruiting teachers at all levels, from elementary school to university, is organized nationally. For primary and secondary schools, it is based on selective exams, whereas at the university level, the scientific work of the candidates is the primary criterion.

IV. Mathematics as a Service Discipline

University students of many faculties must attend one or more mathematics courses. Here are some typical examples: computer science (5 one-year math. courses, some of them split into two semesters), physics (4 math. courses), chemistry (3 math. courses), biology (2 math. courses), engineering (4 math. courses), economics (3 math. courses), medicine (1 math. semester only). Most of these courses are taught by mathematicians in a rather formal and theoretical fashion, but physicists, chemists and engineers tend to involve their own staff in the teaching of some of the more specific courses, such as “mathematical methods for physics, for chemistry, for engineering”.

V. Research into Mathematics Teaching

There is a growing interest in this field. In several universities there are active groups (called Nuclei di ricerca didattica) of university and school teachers working together on innovative projects, but the centralized structure of the Italian school system allows only for a limited freedom with respect to the national syllabi. Nevertheless, these groups have had a positive influence on the updating of