

## Chapter 3

### Reform in Science Teacher Education in Italy

#### *The Case of Physics*

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**Abstract:** In this chapter, we present the problem of the initial preparation of science teachers in Italy. We describe prospective changes both for the preparation of primary school and secondary school teachers and compare with the present situation. We draw attention, in particular, to the preparation of physics teachers as an example of science teacher preparation. Here we report the complete path of their studies (undergraduate and graduate) and discuss the main features that graduate courses should have to prepare effectively preservice teachers for their future work.

At the present time, education in science is accepted as crucial for the cultural development of individuals. The improvement of science teacher preparation is a common aim in different countries. Consistent efforts in this direction are making progress in Italy: changes in teacher preparation have been established by law and a reform of the whole school system is now under discussion. This chapter aims at presenting these changes.

In order to provide a frame, a brief presentation of the Italian school system is initially given. Next the current teacher education system is described. Third we present innovations in teacher preparation for primary and secondary school, focusing on the main features of the new undergraduate and graduate courses respectively for primary school teachers and high school teachers. The case of physics is considered in detail, by drawing attention to the fundamental criteria on which the organization of courses and methodological choices are grounded. We also show how considerations about physics teacher preparation can be extended to other scientific disciplines.

## THE PRESENT ITALIAN SCHOOL SYSTEM

Children enter compulsory school at six years (generally after three years of preschool), and complete it after five years of primary school and three years of junior secondary school. (A law that deeply modifies the organization of our school system, establishing compulsory schooling from 5 to 15 years of age, is now under discussion and it is expected to be approved in the near future).

Compulsory schooling (see Table 1) is the same for all children, including those with mental or physical disabilities for whom specialized support is provided.

*Table 1. The Present Italian School System*

School	Duration (Years)	Starting Age (Years)
Preschool	3	3
Primary school*	5	6
Junior secondary school*	3	11
High school	5	14
University	4 (5-6)	19

\* indicates compulsory schooling

According to the national syllabus introduced in 1985, science should be taught from the very beginning of primary school without a separation of scientific disciplines. Presently teaching activity is shared by three teachers, one of whom has the responsibility for science and mathematics education. In junior secondary school (which is compulsory and lasts three years), the number of teachers increases to eight, but mathematics and science are still taught by the same teacher.

High school (non-compulsory) lasts five years and consists of different sections: Liceo Scientifico (oriented to science and mathematics), Liceo Classico (oriented to the humanities), Liceo Artistico (oriented to the fine arts), and a number of Technical Institutes (Commercial, Industrial, Agricultural, Construction, etc.). As in compulsory school, the syllabus is established at the national level. Scientific disciplines are taught by specialist teachers. In particular, mathematics and physics can be taught by the same teacher; biology, chemistry and health science are taught by another teacher. At the end of high school, students have to pass an examination designed by a national committee for each section of high school. After this examination, students may start state university without passing an entrance examination. (For a few disciplines the enrollment is limited and a selection of students is made by means of tests. The total number of Italian state universities is 64; the number of private universities is quite low). The preparation of students

who enter the university is generally based more on humanities than on scientific subjects; a high frequency of drop-out is common, especially for undergraduate students in scientific disciplines.

## **PREPARATION OF TEACHERS**

In order to show how deeply the preparation of teachers will change in the near future, the present teacher education system is briefly illustrated. Since the preparation of teachers strongly depends on the school teaching level, the case of primary school teachers is described separately from that of secondary school teachers.

### **The Present Situation**

#### **Primary School Teachers**

According to a long tradition, primary school teachers are prepared in a special section of high school (Istituto Magistrale). They do not earn a university degree and they usually receive a preparation oriented to methodology rather than to disciplines, especially in science (Borghi, De Ambrosis, and Massara, 1991). The seriousness of their limited education in science was emphasized when the new national curriculum for Italian primary school was introduced. It required that science education be an essential part of primary school from the very beginning and, in accordance with research findings, the science curriculum be experience-oriented (for example, see Bazzini et al., 1985; Bonera, Borghi, De Ambrosis, and Massara, 1983; Bonera, Castellani Bisi, Borghi, De Ambrosis, and Massara, 1981; Goldberg & Boulanger, 1981; Karplus & Their, 1970; McDermott, 1976, 1990a).

A consistent effort to enhance primary teachers' background in science and to equip them with the tools necessary to improve their skills in science teaching has been carried out by the Italian Ministry of Education by launching a national plan of professional development for inservice elementary school teachers lasting five years. About 300,000 primary school teachers were engaged in compulsory courses (aimed at preparing teachers to implement the new curriculum in the classroom) in the following areas: art, languages, history and geography, mathematics, music, and science. The implementation of the national plan of training allowed the research groups in science education in a few Italian universities to test the effectiveness of their research on teacher preparation in proposing new models of inservice education (Borghi, De Ambrosis, and Massara, 1993). In particular, our

experience in a number of courses confirmed that, inside the field of science education for teachers, physics can play a fundamental role, because it allows a complete path from the experiential phase to the formal one. This is to say that teachers must have a good knowledge of fundamental concepts of physics, and have direct experience of what a physics experiment is. We considered it necessary to help primary school teachers acquire significant experience in working with equipment, in recognizing the essential variables in an experiment, in testing models, etc.

The work carried out with inservice teachers suggested guidelines for designing the new project for initial university preparation of primary school teachers which we describe later in this chapter.

### **Secondary School Teachers**

Teachers of scientific disciplines are prepared at the university where they earn one of the traditional science degrees: Biology, Chemistry, Geology, Mathematics, or Physics. For most disciplines, teaching-oriented courses are not offered and, even when such courses are available (as is the case of physics in a limited number of universities) they are not compulsory. In order to be admitted to high school teaching in public schools, besides having a degree in the discipline, passing a national qualifying examination is required. Teaching positions are conferred through a national competitive examination.

The instruction in the subject matter provided by university courses is sound but specialized in each discipline. It fits with the separation of scientific areas in high school, but it is generally too narrow to cover the range of scientific disciplines in junior high school. In any case, teaching as an activity of mediation between discipline and knowledge building of students is usually disregarded. Practicing teachers usually try to fill this lack by attending professional development courses, often funded by the Ministry of Education and organized by different public institutions such as: their schools, teacher associations, Regional Institutes of Educational Research (IRRSAE) and the Ministry. These courses are not compulsory and do not have common features. Based on our experience, teachers appreciate courses grounded in laboratory activity that give them the opportunity to develop and test experiments to include in their teaching practice.

A national plan, National Plan for Computer Science, for inservice teacher education was organized, starting in 1985, with the aim of introducing the use of computers to improve learning in different disciplines, in particular in mathematics and physics. These courses have given inservice teachers the opportunity of participating in the debate on the use of new technologies in science teaching (Arons, 1984, 1990; Bacon, 1992; Hewson,

1985; Hicks & Laue, 1989; McDermott, 1990b; Schwartz, 1989; Taylor, 1987, 1988).

Universities also provide specialized courses on different subjects. The involvement of university researchers in science education in a number of courses allows teachers to gain awareness of the existing research on teaching and learning while providing researchers with new insights on teachers' needs and problems.

## **The Prospective Situation**

A recent law assigns the universities a fundamental role in the education of teachers at every school level. It establishes major changes in initial teacher preparation both for primary and secondary school.

### **Primary School Teachers**

According to the new law, starting from the academic year 1998-99, people who want to become primary-school or preschool teachers, must earn a university degree (4-year) by following a specific curriculum, including courses in content and professional education. The law establishes general criteria and guidelines for the preparation of teachers and gives universities the complete responsibility for organizing the courses. In particular, teachers are expected to attend courses for eight 6-month periods (2,000-2,400 hours total). The percentages of time devoted respectively to disciplinary, general education, laboratory, and teaching practice, must be at least 35%, 20%, 10%, 20%. Professional courses cover 5% and the remaining time can be devoted to elective courses. In the first two years, courses are common to preschool and primary preservice teachers.

As an example, in Table 2 we report the proposal of a committee of the Ministry of Education (MPI) and the Ministry of University and Scientific and Technological Research (MURST). The total number of semester courses to be attended in four years is 50, including eight courses for teaching practice and six elective courses.

As Table 2 shows, 17 courses are devoted to content matter in different areas and are accompanied by teaching practice. A preservice teacher is expected to delve into two of these areas, with not more than one selected from arts, music, and physical education.

A thesis is required and its discussion is part of the final examination. Courses and thesis work aim at developing competence both in subject matter and in cognitive and methodological aspects of teaching. They offer the possibility of building a bridge between psycho-pedagogist and subject

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