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TOWARDS A SCHOOL OF SPECIALIZATION FOR CHEMISTRY TEACHERS IN ITALY: THE TUSCAN EXPERIENCE

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ABSTRACT: In preparation for the introduction in Italy of a 2-year post-graduate school of specialization, as foreseen by a law passed in 1990 but not yet in force, the academic senates of the three Tuscan universities in Florence, Pisa and Siena have appointed a proposals committee to study the feasibility of the school in Tuscany. The school will have as its aim the cultural and professional training of chemistry teachers for the upper secondary school and its basic contents will cover the following areas: Area 1: training as a teacher; Area 2: subject-specific training; Area 3: didactics laboratories; Area 4: practical teaching. This paper aims to illustrate the critical line of thought followed by the *Tuscan Proposals Committee* in the contents of the above-mentioned areas. [*Chem. Educ. Res. Pract. Eur.*: 2000, *1*, 303-311]

KEY WORDS: *chemistry teachers; subject training; didactics laboratory; practical teaching; training as teacher*

INTRODUCTION: PRESERVICE AND IN-SERVICE TRAINING OF SCIENCE TEACHERS AT THE UNIVERSITY OF PISA

In recent years the chemistry and integrated sciences research group at the University of Pisa has participated in pre-service and in-service training activities.

In-service training activities

(Bargellini, A., Lardicci, L., Raspi, G., & Riani, P., 1989; Bargellini, 1991; Bargellini, A. & Riani, P., 1991).

a) Elementary school level

Science teaching acquired an autonomous role for the first time with the introduction in 1987 of the new Italian science programme based on the themes: physical and chemical phenomena; the environment and natural cycles; organisms: plants, animals and man; man and nature; the man-made world. In-service training for elementary school teachers was proposed as follows:

Objectives. The acquisition of a) a minimum level of chemical language; b) some basic chemical concepts and processes; c) an awareness of the importance of chemical knowledge in

relationships between people, society and the environment.

Contents: a) the structure of chemistry: physical states of matter, changes of state, systems (mixtures and solutions), chemical substances, chemical interaction, acids and bases; b) the relevance of chemistry: problems of health, food, energy resources, the environment.

b) Middle school level (11-14 years of age)

The following six units of instruction were prepared and experimented in schools: the physical states of matter, changes of state, solutions, elements and compounds, chemical interaction, acids and bases.

Pre-service training activities
(Bargellini *et al*., 1996)

In view of the creation of a school of specialization in teaching, the University of Pisa recently held two training courses for future teachers at upper and lower secondary school levels. The courses included teaching practice activities and subject-based didactics, general pedagogy and didactics, the psychology of education, the psychology of the evolutive age, learning and behavioural difficulties.

In the field of chemistry, the materials proposed for all activities were prepared on the basis of research carried out for many years with teachers and pupils. Teachers were required to carry out experimental activities designed for children working in pairs; laboratories or classrooms were organized with low-cost, flexible and safe materials.

The didactic methodology followed was based on D.P. Ausubel's theory and proposed the method of guided discovery in order to reach meaningful learning. The pupils, placed in a stimulating situation, are guided to observe objects and organisms, to discover properties, relationships and links with the environment in which they live. The teacher follows his pupils, guiding them in their observations and enquiries, stimulating them to continuous critical thinking.

During more recent activities, the methodology has been more markedly constructivist.

TOWARDS A SCHOOL OF SPECIALIZATION FOR TEACHERS IN TUSCANY: HYPOTHESIS FOR SCIENCE TEACHER TRAINING

A 2-year postgraduate course of specialization for teachers is to be introduced in Italy on the basis of a law passed in 1990 but not yet in force.

The academic senates of the three Tuscan universities in Florence, Pisa and Siena have appointed a proposals committee to study the feasibility of the school in Tuscany. Here as follows are some of the indications prepared by the committee with regard to the teacher training process.

Minimum qualifying contents necessary for the preparation of teachers involve didactic activities and relative passes in the following areas:

Area 1: Training as a teacher. This includes didactic activities aimed at the acquisition of necessary attitudes and competence in the science of education as well as in other aspects relative to the position of teacher.

Area 2: Subject-specific training. This includes didactic activities aimed at the acquisition of attitudes and competence relative to subject methodology, with particular attention to the logical aspects, the genesis, historical development, epistemological implications, practical meaning and social functions of each branch of knowledge.

Area 3: Laboratory. With specific reference to the formative contents of various subjects.

Area 4: Teaching practice.

Profile of the teacher

In relation to the present-day organization of the middle school, it is held that the most suitable profile for a mathematics and science teacher is that of a single teacher who has more specific training in two subjects than in the others. This model should allow for more weight in the subject training sector and the acquisition of more specific competence in the field of the chosen subjects.

The training of this single teacher will include preparation (subject-based, in subject didactics and of epistemological nature) in two of the five subjects involved in the present ministerial programmes: 1) mathematics with elements of computer sciences; 2) biology; 3) physics; 4) chemistry; 5) earth sciences.

For students who are not graduates in mathematics, physics or chemistry, one of the two subjects must necessarily be mathematics. The relative preparation will require an increased length of time for theoretical studies, laboratory activities and teaching practice. The group of subjects in which the student will receive more specialized preparation will be denoted "basic subjects" as distinct from "other subjects". Rather than at a quantitative increase in knowledge, specific preparation will aim at the development of critical capacities and methodologies relative to the chosen subjects. In particular a thorough knowledge of the structure, the didactics, the history and specific epistemology of the two main subjects will constitute a significative general reference model.

AREA 2: SUBJECT-SPECIFIC TRAINING

Study plan

Subject areas and training activities

a) the subject areas corresponding to the five previously mentioned subjects;
b) all subject didactics;
c) subject didactics laboratories;
d) historical-epistemological foundations of the two chosen main subjects.

Details of the proposed training with time allotments

To allow for maximum flexibility of individual didactics programmes, it is proposed to group the didactic activities in rather brief modules (from 10 to 30 hours). The 220 hours available for the subject area are indicated as follows:

1st year / 1st Semester: Basic subjects

Didactics and epistemology of subject A	30 hours
Didactics and epistemology of subject B	30 hours

1st year / 2nd Semester: Basic subjects

Didactics and epistemology of subject A	20 hours
Didactics and epistemology of subject B	20 hours

Other subjects

Didactics of integrated sciences	20 hours

2nd year / 1st Semester: Basic subjects

Didactics and epistemology of subject A	20 hours
Didactics and epistemology of subject B	20 hours

Other subjects

Didactics of integrated sciences	20 hours

2nd year / 2nd Semester: Project area

Curricular development of models and didactic units regarding the topic and requiring an integrated scientific vision	40 hours

Indications relative to the didactic and epistemological content of each of the two subjects (A or B)

The following topics are susceptible to further development and interpretation by teachers in each of the subjects.

Epistemological bases of the subject

- Knowledge-based role of the subject.
- Significance of the subject in cultural development. Historical-critical development of the subject.
- The subject's conceptual nodes.
- The subject's specific language and communication methods.
- Cognitive obstacles and their role in the teaching-learning process.

Subject didactics

- The nature of the subject (instruments, methods and models).
- Relationship between the nature of the subject and its didactics.
- Historically important projects regarding subject didactics.
- The concepts of curricular development.

- Aims and objectives in the teaching of the subject.
- The role of teaching the subject at the school level concerned.
- Interaction between learning theory and subject didactics.
- The role of language in scientific teaching.
- Didactic methods and models.
- Didactic instruments and technology.
- Didactic sequences and strategies.
- The didactic development of the subject's conceptual nodes.
- Cognitive obstacles and didactic itineraries.
- Teaching the subject within the scope of integrated sciences.
- Interaction of the subject with environmental studies and health education.
- Criteria and methods for the testing of learning in the subject.

Indications relative to the didactic contents of integrated sciences

In treating the development of content relating to this part of the course, particular attention will be given to what has been accomplished in this sector at both national and international level.

Integrated science didactics

- Aims and objectives in the teaching of integrated sciences.
- Principles and methods used in the teaching of integrated sciences.
- The treatment of significative foreign projects in the field of integrated science teaching for the same school levels.
- Contribution of the teaching of integrated sciences to environmental studies.

AREA 3: LABORATORY WITH SPECIFIC REFERENCE TO THE TRAINING CONTENT OF COURSES

Study plan

The study plan indicated as followed has been arranged so as to reduce to a minimum the total number of courses to be made operative and at the same time to leave the student a certain degree of freedom and allow the attainment of double qualifications.

1st year / 1st Semester**:** Basic subjects

Didactics laboratory in subject A	25 hours
Didactics laboratory in subject B	25 hours

1st year / 2nd Semester: Basic subjects

Didactics laboratory in subject A	20 hours
Didactics laboratory in subject B	20 hours

Other subjects
Didactics laboratory in integrated sciences 20 hours

2nd year / 1st Semester: Basic subjects

Didactics laboratory in subject A 20 hours
Didactics laboratory in subject B 20 hours

Other subjects
Didactics laboratory in integrated sciences 20 hours

2nd year / 2nd Semester: Project area

Curriculum based experimentation of modules and didactic units concerning a topic that requires an integrated scientific vision 30 hours

Indications relative to the laboratory activities

Organization, management and operation of the laboratory

The operation of the laboratory and the management of the 200 hours of activity that are to be carried out by the students on any particular course, are entrusted to a team consisting of the following persons:

1. A number of teachers of didactics in the various subjects making up the area (mathematics, computer science, chemistry, physics, biology, earth sciences).
2. A formation sciences teacher.
3. An expert secondary teacher (supervisor).

The organization and mangement of the laboratory activities are entrusted to one of the subject didactics teachers.

Laboratory activities

Activities carried out in the laboratory constitute the departure point for planning teacher training in schools. The development of these activities can therefore be foreseen as containing the following stages:

a. Arrangement of activities from the epistemological-didactic point of view.
b. Planning and experimentation of units and/or didactic modules in the laboratory.
c. Critical analysis and evaluation of the didactic materials produced.
d. Application of the materials produced in the classroom during training activities.
e. Return of the didactic materials experimented in class to the laboratory and their eventual definitive revision.

On the operational plane the following types of didactic laboratories can be foreseen:

a. Subject area (common to several qualification classes).
b. Specific areas for qualification classes (subdivided by qualification class).

Subject didactics laboratory activities

The laboratory activities are planned partly as a function of the characteristics of the school environment and concern the following points:

a. Planning of units and/or didactic modules and their evaluation (within the scope of the link between didactics laboratory activities and teacher training).
b. Planning and preparation of didactic materials (equipment both of a complex and a low-cost nature, models, transparencies, cards, slides, video), in the aim of experimenting the planned didactic modules and units.
c. Comparison of alternative didactic hypotheses.
d. A critical analysis of: text booksp; cards concerning the various stages of curriculum development; videos; didactic software; modelization processes and types of model used in the didactics of various subjects making up the course;
e. Preparation and use of evaluation and testing instruments.

AREA 4: TEACHING PRACTICE

Programming the 280 hours of area 4 (teaching practice)

After having participated in the laboratory activities, the student-teacher is assigned to a specially chosen expert teacher (tutor). In a previously selected and suitable structured laboratory school, the student carries out two periods of teaching practice under the tutor's guidance.

1st year: 1st period of teaching practice (passive, 100 hours)

During this period the student-teacher mostly follows and observes the tutor's activity, assisting him in the programming of modules and didactic courses, as well as in the preparation of all the didactic material necessary for their realization.

2nd year: 2nd period of teaching practice (active, 100 hours)

During this second period the student-teacher continues to assist the tutor in his various activities, at the same time assuming the role of active teacher. During this second phase, as well as didactic activities, the student teacher is engaged in didactics research (80 hours).

On conclusion of the two teaching practice periods the student-teacher should have acquired the following abilities/expertise of a professional nature:

a) the ability to communicate in scientific language;
b) the ability to effect observations;
c) the ability to solve problems of an experimental nature;

d) expertise relative to the historical evolution of the experimental sciences;
e) awareness of the influence exercised by the development of science on society and the economy;
f) expertise relative to health and the environment.

Functions of the supervisor and the tutor

Functions of the supervisor or teaching practice coordinator

The supervisor, who will be responsible for not more than 7-8 tutors, carries out the following functions:

1. participates in all the activities concerning the planning of didactic materials carried out in the laboratory;
2. informs the tutors on the didactics-methodological and content aspects of the models elaborated and experimented in the laboratory;
3. is in contact with the tutors and coordinates them, partly in view of an evaluation of the teaching practice activity carried out by the students;
4. together with other members of the team, participates in the evaluation of the teaching practice activities carried out by students.

Functions of the tutor

The tutor is an expert teacher in the subject area and is responsible for following no more than two student-teachers during both their passive and active teaching practice activities.
Furthermore, the tutor collaborates with the teaching practice supervisor in correlating the laboratory and teaching practice activities and in formulating a final evaluation on the level of professionality reached by the students in relation to the activities carried out during the two teaching practice periods.

Relationship between laboratory and teaching practice activities

During the teaching practice activities the modules elaborated in the laboratory are experimented in the pilot classes by the student-teachers under the guidance of their tutors. Following the experimental activity in class, the modules return to the laboratory to undergo critical analysis and eventual revision in the light of experience, before becoming definitive.

Programming the 100 hours for the final report

On conclusion of the training programme followed, the future teacher will be required to prepare a final report regarding the fundamental aspects of the didactic and research activities carried out. The present programming hypothesis provides for attendance at a minimum of two semester courses on “foundations and methods in two subjects of an experimental nature” (to be chosen from biology, earth sciences and chemistry), for graduates in mathematics and physics.

Credits

It is planned to offer credits to any student whose degree course included subjects with contents corresponding to those of the courses offered by the school. In this case students may present for an integrating test that will be evaluated by a school board commission.

Minimum requirements and debts

The subcommittee also examined the problem of the relevance of knowledge acquired in various degree courses that allow access to the fixed-quota classes and presents a number of suggestions to allow the enrolement of candidates with subject inadequacies.

For each of the specialization classes, a list has been prepared indicating the subject competencies held to be necessary in order that the future teacher may have, at least initially, adequate knowledge of the subject to be taught.

Students who have acquired all the listed competencies during their degree courses can enrol directly, while those presenting inadequacies (debts) must integrate their knowledge. In these cases the Board will indicate what form integration is to take. Generally speaking it will require attendance at suitable university courses for which it is suggested that special conventions be stipulated with the faculties concerned. Integration will be validated either by passing the university examination for the course, or a special examination set by a school board commission (this is because the university course and relative examination could be of a higher level than that required for integration). Clearly those students who wish to enrol simultaneously for two specialization classes must satisfy requirements for both classes.

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