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Training of Science Teachers in Italy

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Abstract

The paper describes the training that science teachers receive in Italy and underlines the lack of important skills such as pedagogical and educational skills.

Few guidelines to teach science at school are given on the base of the experience of researchers expert in teachers' training. In particular, the problem of communication between teachers and students is addressed and suggestions are given in order to make it effective, thus minimizing the difference between what the teacher means and what the student perceives.

Few words of cautions are also given as regards to the laboratorial approach: it is a very useful teaching tool to develop the cognitive autonomy of pupils, but it has to be used in the correct way.

1. The image of chemistry teachers and their training

Chemistry is recognized by students as one of the most difficult and boring subjects and too often the responsibility of students' low motivation and performance is assigned to teachers. As a matter of fact, they are considered experts of the discipline, but unable to present it under a more capturing light, or to explain the abstract contents in a more suitable way. It's a common opinion that they should continuously update their teaching methodology, by using different approaches and tools, in order to satisfy the needs of each student and the changes in society.

These statements cannot be shared by people that work in the field of education and know too well that teachers, not only chemistry/science teachers, do not often receive an adequate preparation and find it difficult to deal with colleagues. When students do not learn it's just too easy to blame teachers simply arguing that they should find ways to better teach; it is much more useful to know how teachers are trained initially and what is provided to ensure their in-service training.

Teachers, and much more science teachers, cannot be trivial dispensers of information but must become professionals with specific and synergic skills:

- Disciplinary skills. This is a necessary, but not sufficient condition.
- Educational skills related to their discipline. These skills are needed because they make teachers able to plan and cope with learning situations.
- Pedagogic skills. In order to face the complex social and psychological problems that arise within the class.
- Actually, the above skills are only partially provided by courses for initial training:
 - degree courses for primary school teachers ("Sciences of Primary Education");
 - one-year postgraduate schools (TFA) for secondary school teachers; these courses are differentiated in terms of school grade (lower or upper secondary school) and of discipline.

For what concerns in-service training, they are sporadic and not compulsory. The most significant are national projects financed by the Ministry of Education, University and Research (MIUR) and provided



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by Universities, or courses provided by INDIRE (National Institute of Documentation for Innovation and Educational Research) with the support of European Structural Funds (FSE).

2. In-service training of science teachers

For what concerns scientific disciplines, the in-service training of teachers is mainly provided by the projects “Teaching Experimental Sciences” [1], “Scientific Degrees Plan” [2] and PON Science Education [3].

“Teaching Experimental Sciences” (ISS) is a national project addressed to teachers of primary and of the first two years of secondary school; it aims to improve the methodological approach in the teaching of scientific disciplines recognizing the centrality of the student. ISS has the final objective of enhancing the scientific literacy of Italian students, above all by providing the continuous in-service training of teachers and promoting, by the work of the teachers themselves, important scientific educational experiences and practices. In other words ISS aims to enhance learning through the improvement of teaching. The main project activities consist in a continuous educational research (research-action) made by teachers, experts and researchers. Teachers choose the contents to develop, then design and carry out new practices with their students. The new practices are assessed on the base of students’ response and learning, are shared with other teachers, are discussed with the experts and, if needed, are corrected and tested again. A characteristic of IIS plan is the implementation of laboratory didactics mainly intended like laboratory of the mind, as a tool to accompany students through the experience of the experimental research, that foresees discussion, critical analysis and the possible crisis of the protocol itself. In this modern perspective, teacher is no longer the person who says what to do and explains the contents of a discipline, but is a guide accompanying the student through the construction of his knowledge, by the critical analysis of what he sees and the discussion with his peers.

Also “Scientific Degrees Plan” (PLS) is a national project, addressed to upper secondary school and financed from the Ministry of Education: the first edition started in 2005. The motivations of the project reside in the low scientific literacy of Italian students, assessed by national and international surveys, but also in the crisis of technical and professional schools as well as of scientific courses of degree (chemistry is an example). The project realized a great success in improving the teaching-learning methodology in upper secondary school, thus convincing the Ministry of Education to renovate its financial support year by year; in 2010, the project was promoted to ‘Scientific Degrees Plan’, in order to underline its important role as tool to improve scientific literacy and its continuity also in the next years. PLS, in synergy with ISS, aims to increase scientific motivation both by involving students in practical activities and by improving teacher skills. It’s major point of strength is the joint effort between school teachers and university researcher in a work of planning and production of new tools for a more efficacious teaching of chemistry.

The national program ‘PON Science Education’, is part of a larger program dedicated to the training of teachers (PON 2007-2013). Its main objective is to improve the quality of science teaching in order to improve the level of science learning of students. This project is provided by INDIRE, a National Institution that has the task of accompanying the evolution of the Italian school system by investing in research, experimentation and innovation. With regard to teachers, INDIRE aims at improving the performance of teachers in their educational practice, in making school every day, through the provision of innovative solutions both from the methodological point of view, and from the contents, methodologies and technologies. The training model is blended, meaning that it integrates activities in presence and activities on-line.

3. Few guidelines to teach science at school

The teaching of science at school leads to face different situations and problems and to use different tools.

In particular, we will focus on the problem of communication and of the use of the laboratorial approach.



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3.1 Communication

The primary task of teaching should be to identify the conditions that can make communication effective; in other words, the most appropriate conditions to minimize the difference between what the teacher means and what the student perceives. This is particularly difficult when the subject taught is chemistry, because of the relationship between the macroscopic and the microscopic models and of the necessity of using symbols.

Three main contents are involved in communication at school [4]: the language, 2. the requisites, 3. students' interest and motivation

The language

Teachers should take the language into a great consideration, despite the discipline they teach: they should use, as much as possible, words of the common language, at least initially (it means starting from the language of their pupils), and, at the same time, they should work to enhance the linguistic skills of their students. Pupils' linguistic problems occur from the beginning of primary school, since the very first day of school: It's when the kids realize that some topics are difficult for them to get through and, thinking they won't be able to understand, they will rather use their memory than their brain to learn. This somehow inevitable choice, is irreversible because if the pupil gets good results by memorizing and repeating, he will continue and become increasingly able at this feature; memorizing requires less effort than understanding, and students will hardly choose this option, particularly those who have never been purposely trained.

The requisites

When the addressees of a message haven't got the necessary requisites to interpret it, this creates problems in communication. In this case, we refer to the conceptual requisites, skills and abilities that are essential in order to understand what is being proposed. For this reason the choice of contents becomes an extremely important factor in school, a factor often overlooked in favour of the method. The method is certainly important but so is the quality of the contents that the teacher offers, as there are contents that need multiple requisites and contents that require the possession of fewer requisites.

The motivation

Once the teacher has created adequate conditions so that the message is understood as the teacher wants, there is the problem of passing from the so-called comprehensibility of the message to its proper understanding by the recipient. Interest and motivation are factors that influence the transition from comprehensibility to proper understanding. As a matter of fact, there is a strong relationship between learning and interest in learning: it could be argued that if pupils have no reasons to understand, the learning will be very hardly achieved. It is necessary to identify appropriate tactics and strategies to attract the students' interest, to make sure that they feel the need to "look for explanations."

Explanation is strongly connected with problems in communication and it's useful to spend some words to clarify its meaning and role [5].

An explanation about scientific subjects, can be really considered as such, only if the pupils are able to understand it, otherwise it loses its educational value. The teacher, therefore, must always calibrate his/her didactic proposals taking into account the requisites of his/her students: only when the explanation takes into account the cognitive level of the recipients, it can establish a functional communication towards learning. Moreover, it is necessary that teachers, as well as their pupils, are able to distinguish between the explanation of a phenomenon and its description.

Unfortunately, the training that many teachers have received did not favour the acquisition of a critical and reflective behaviour: during their teaching activities they tend to repeat to their students the same 'explanations' stored or partially understood when they were students. As an example, we can consider the transition of a pure substance from the solid to the liquid state: this is a familiar phenomenon and therefore, being erroneously considered simple, it is treated with excessive superficiality also from textbooks that often provide explanations that do not really justify the macroscopic behaviour.



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3.2 The laboratorial approach

The laboratorial approach is a very useful tool for teaching to develop the cognitive autonomy of pupils [6]. It is a methodology that valorises the experimental approach to problem solving and enhances its educational potential. It foresees a sequence of actions where the student is not a banal performer that follows the instructions of a recipe, but a person who reflects about the way the experiment should be carried out, performs it, collects data, analyses the results and communicates them. This way of working allows to raise the logical-linguistic skills of pupils, the ability of evaluating their knowledge and the ability to relate to others. Everything can happen only through a systematic request of expressing their points of view, compare them with their classmates' and verify their claims.

The operative sequence to follow during a laboratorial path is the following:

- focus on the specific topic that will be dealt with, through the description or presentation of an experience (this applies in particular to the experimental sciences) or a short written text (this approach is used for all disciplines)
- individual written work: each pupil has to express his point of view about the topic. The work has to be performed by the use of a worksheet where the teacher clearly indicates what is requested by the students. The task usually consists in one or more specific open questions
- written work made by small groups (on another related worksheet): pupils compare the individual answers and try to reach a unique shared answer. Should different points of view persist, they must be written
- presentation of the conclusions by the representatives of each group; the teacher will try to build up a summary of the results
- teacher's considerations about the topic dealt with, additional information and suggestions.

From the above discussion, we can deduce that the laboratorial approach is not trivially a practical experience that students carry out in the lab by following a pre-constituted recipe, but it can consist in a more complex path. Following this methodology, the experimental approach to scientific problem solving consists in designing and performing an experiment, collecting data and analysing results, but also in enhancing pupils' ability to express their points of view, to compare them with those of their fellows and to reflect about what they have done and thought during the activity. In this way pupils increase their self-esteem, their cognitive autonomy and their metacognitive skills.

Finally, it is worth underlining that, if we want motivational aspects, laboratories and other educational tools have a positive role, it is indispensable to realize an efficacious communication by choosing suitable contents. Only if the recipients possess the necessary cognitive requirements and the transversal basic skills, the new knowledge can interact with what they already know.

4. Conclusions

Italy provides a insufficient training to its science teachers, both with regard to initial training, that with regard to in-service training. Teachers often exhibit a good knowledge about their discipline, but often complain of not having good teaching skills, organizational, interpersonal and communication skills.

In the light of this situation, the system of teacher education is evolving, but with great difficulty. In fact the training offer is of good level, but too sporadic and not sufficiently structured.

In order to make teachers "experts of teaching" it is necessary to establish centres of initial and in-service training throughout the national territory and have the total support of the Institutions. These centres should rely on the collaboration of experts in the curricular disciplines, but also in education, psychology and pedagogy; they should also update continuously their research and training offer in order to satisfy the needs of teachers and schools of each grade and level.

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