CULTURAL AND PROFESSIONAL ASPECTS IN TEACHER TRAINING: SOME HYPOTHESIS AND EXAMPLES OF ACTIVITIES

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1. Our research activity

In teacher education different objectives can be pursued, different aspects can be focused, different attention can be paid to different kinds of preparation. Our contribution is mainly focused on the problems arising with prospective and in service teachers at grades K-8 and 9-12 (students 3-10 and 11-14 years old).

Our research activity, within the national projects SeCiF, FFC, SeT concerns the pre[1] and in-service K-12 teacher education and it is aimed:

- to design a model for in-service and pre-service education for physics teachers;
- to create a practice community of teachers working in school and communicating through the network, collaborating among them and with university researchers and perspective teachers;
- to prepare Web materials useful for both pre and in service teacher training (in particular for at-a-distance training at individual or community level);
- to involve teachers in designing and implementing Web materials containing reports of classroom activities and didactic proposals for colleagues and students.

In particular, in this contribute we want to synthetically illustrate the basic lines of the training model, of the network collaboration and of the web products about pre-service and in-service teacher training.

2. Teacher education: cultural aspects

According to a constructivist view of the teaching/learning process, we think that the teacher must substantially play a mediation role between each student's culture and the history based culture. About the scientific knowledge, coherently teacher training must enable the teacher to elaborate and to manage gradual connections between the two processes of knowledge construction: the spontaneous and the scientific one. The first one is unconscious, idiosyncratic, aimed to personal goals; the second structured, conscious, and aimed to development of socially shareable descriptions/interpretations of natural events and of technological reality.
Long-term researches, developed at different school levels, showed the possibility/necessity to uninterruptedly carry out this project along all the school years. (M. Gagliardi, N. Grimellini Tomasini, B. Pecori, 1999a; E. Giordano 2002). In order to realize a mediation process able to foster a meaningful cultural development, it is necessary (M. Gagliardi, N. Grimellini Tomasini, B. Pecori, 1999b):

- engaging students at a proper cognitive level;
- involving students spontaneous knowledge and their attitudes to work about the considered field;
- making students more and more aware of features, roles and values that characterize both spontaneous and scientific knowledge;

[1] Since only few years in Italy exists a four years graduate course for infant and primary school teachers (PFS) and a two years post-graduate course (SSIS) for science (mathematics, biology, chemistry, earth science, physics) teachers in junior Secondary school.

- reproducing in classroom work the social aspect of the process of the disciplinary knowledge construction.

These goals can be reached through teaching paths (M. Gagliardi, 2002) that:

- start from the students' everyday experiences;
- trigger the students resources on the plan of the cognitive operations, the practical actions, the social communications, using questions-problems adequate to their developing possibilities;
- widely explore the problems first at qualitative level and then at quantitative level;
- enable students to gradually move from observation and discussion of everyday situations to the proposal, execution, discussion of experiences more and more schematized and controllable, up to experiments with measurement activities.

Even if in everyday situations there are aspects for which a scientifically corrected explanation is far from the cognitive possibility of the pupils, we think that a preventive sterilization of the studied phenomena must be avoided. Indeed, we look at scientific education as a game of "looking for answers"; questions are the core of teaching paths and finding answers involves a continuous game of explorations, formulation of hypothesis, experimentations and verifications. During the path the initial questions/problems change, the answers/solutions appear to be always partial because new questions/problems arise and the construction of knowledge is highlighted as an open pathway where every new conquest becomes a base for further conquests. So, the impossibility to reach all the answers "scientifically correct" is not a reason to avoid looking, thinking, making experiences and building hypothesis; moreover the unanswered questions can motivate investigations in the following school years, when the necessary instruments (cognitive strategies, formal languages, lab abilities...) will be available.

In order implement such a teaching model in their classrooms, teachers must recognize connections between the infant knowledge, the common sense adult knowledge, the scientific knowledge and, in particular, the physics knowledge. In order to reach this aim, teacher training activities must have the same features of the above indicated students' activities and, further more, a level of meta-cognitive reflection on the teaching/learning process. (P. Bonelli Majorino, Gagliardi M., Giordano E., 2003). So, our training model foresees, in selected phenomenological fields, activities of cultural/disciplinary formation (hands-on explorations, discussions, formalisations at different levels) that the teachers (perspective or in-service) are supported to carry out in first person, working at collective level of small and large group. The phenomenological fields have to be the following features:

- concerning everyday experience/knowledge;
- being suitable to sprout out different perspectives to be progressively linked with different subject matters (from the humanistic to the scientific ones);
- being relevant for constructing the basic elements of scientific (physics) knowledge.

3. Teacher education: professional aspects

In order to plan and manage teaching pathways suitable for one's classroom specific contests, a teacher must have the following *specific professional abilities*:

- to be able to fit the work level in with pupils' different ages, in the sense of Vigotsky's proximal development area;
- to be aware that students often have strongly rooted ideas about natural events, arising from spontaneous interpretation of everyday experience or from past scholastic learning. The teacher must recognize and manage these ideas, that are frequently in contrast to scientific knowledge but sometimes presents connections elements with it (Hammer, 1996), in order to make them evolve towards the scientific knowledge;

- to be acquainted with the main issues addressed by research in subject education and to be able to use its results for the curriculum development at the different school levels.

A teacher without such professional abilities risks to alternate two opposite choices, both in contrast with an effective science teaching/learning process: the first one is following too strictly some proposal of teaching path that the authors' authority ensures to be disciplinary correct. The second is following only pupil's creativity, without caring about the effectiveness of a progressive "scientific knowledge" construction.

We think that prospective and in-service teachers can reach the above-stated abilities if they have a guided apprenticeship about classroom situations in which they can discuss students and teacher behaviours and analyse different intervention possibilities and their effectiveness.

4. Pre-service and in-service teacher training activities

Pre-service activities are carried out within courses on science subjects education (SSE), educational laboratories on scientific subjects (EL), real classrooms observations (OBS), teaching practice (TP) and, only for infant and elementary school level teachers, courses on the scientific disciplinary foundations (DFC).

DFC are mainly devoted to the cultural aspects of teacher scientific preparation, SSE and EL are devoted both to cultural and professional aspects, OBS and TP to professional aspects.

At the paragraph 2, we have illustrated the kind of activities finalized to the cultural aspects of teacher scientific education.

Concerning the professional education activities within SSE and EL, students analyze and discuss transcripts of emblematic classroom situations, and deal with in-service experienced teachers (used to monitoring the students learning processes in their classrooms) who present some relevant teaching experience underlining significant aspects, raised difficulties and joined results. Finally students can discuss about their OBS experiences.

In TP activities students, putting to the proof their acquired knowledge and competences in real classrooms contexts, can more easily learn to distinguish the typical elements of every classrooms situation from those elements that characterize the specific didactic context in which they operate. This aspect can be particularly encouraged within SSE or EL, comparing different contexts of TP students' activities.

Within in-service teacher education we have tested and improved a model in which teachers alternate:

- activities carried out during periodic university meetings, devoted to managing and developing experiments in class and laboratory and
- activities carried out in their schools, devoted to plan and test innovative teaching paths.

Classrooms experimentations are shared by a net connection among the teachers and the researchers. The community uses a web mailing-list to exchange its activities reports and to share strong points and difficulties, to discuss and analyze the experimented teaching paths and to disseminate them. All the shared material allows researchers to monitor the experimentation and represents the base for further analysis and for final considerations.

This model has been experimented in Lombardia by about twenty junior secondary schools under the management of one of the authors (E. Giordano). These schools since about ten years represent a community of experiences ("Laboratori in rete") for in-service teacher preparation and innovative science teaching. (P. Samek Ludovici, E. Giordano in press; *E. Giordano, C. Portigliotti* 1996; *P. Bonelli Majorino, E. Giordano, G. Rinaudo, S. Roglia* 1996). In the last years the community was extended to new schools of different grade (from elementary to junior secondary schools) and it has offered its experience to the school world and to the initial teacher training. Indeed the "Laboratori in rete" teachers are involved in SSIS and PFS, as EL activities guide or OBS and TP activities supervisors. They have also taken part to national (SeT) and local research projects realizing Web-sites about their innovative teaching paths, with the supervision of university's experts and other

research organization's (Science and Technology Museum, IRRE) experts. The proposals have been published by INDIRE (dedicated site of "Ministero dell'Istruzione Università e Ricerca"): http://www.bdp.it/set/area1_esperienzescuole/cm131/5.htm.
The training model we have talked about involves a limited number of in-service and pre-service teachers. We are now engaged in a more widespread teacher education and we have chosen to realize, within SeCiF and FFC projects, e-learning materials. In particular we have made a web-site about *light* and *vision* phenomena (http://pctidifi.mi.infn.it/lucevisione) and we are working about a second site on the theme "Waves and Oscillations".

We have tried to develop a product able, as much as possible, to reproduce the more qualifying aspects of the described teacher preparation model. In particular, the web-site on light and vision is based on:

- a conceptual path model from everyday experience and knowledge to the scientific knowledge (construction of basic scheme source-object-observer; exploration of three-dimensional shades and light spaces; individualisation of the different phenomenologies concerning the interaction between light and matter; separate study of each phenomenology, re-interpretation of everyday experience);
- several categories of basic elements for the construction of classroom teaching paths (everyday experiences; common knowledge; physics knowledge; pupils ways of looking, doing, communicating; low-cost experiments; mathematical formalisation tools).

The site can be explored and used at different levels and for different goals according to the users' requirements. In particular, for infant and elementary school teachers without any specific preparation, the site can be seen not only as a professional formation tool, but also as a disciplinary preparation tool. (M. Gagliardi, E. Giordano, 2003)

5. Conclusions and perspectives

Besides the web sites relative to the SeT projects, also the written reports realized by the PFS and SSIS students for EL and TP activities evaluation and degree/specialization final exam are useful material for the documentation and the dissemination of innovative experiences planned and performed starting from the research results. In order to encourage positive interactions among School and University, meetings are promoted at University of Milano-Bicocca among in-service teachers, SSIS and PFS students, newly-graduate or newly-specialized and school headmasters in which the more innovative and interesting pre-service teachers' activities are presented and discussed. Activities aimed at maintaining systematic contacts with our graduate students approaching to teaching are also starting, with the aim to support them in their future job and help them to disseminate what they learned during the university experience.
At the end we are planning continuing education activities particularly devoted to our students, in order to increase their cultural and professional level beyond the limits imposed by time-limited pre-service preparation.

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