TEACHERS' CONCEPTIONS ABOUT THE IMPLEMENTATION OF A HPS TEACHING SEQUENCE CONCERNING THE MOVEMENT OF A SIMPLE PENDULUM

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Introduction

During the last decades there were many publications concerning the introduction of elements of history of science in science education, focusing on the use of history of science to support students' understanding (Seroglou & Koumaras 2001). However, little attention has been paid to the dissemination of these teaching programs and their implementation to the ordinary everyday school practice. This work examines the implementation of a teaching sequence, which was developed within a research framework during an innovative teaching intervention, to the regular school environment, in everyday educational conditions, by teachers with short-term training in the subject.

Rationale

It has been pointed that teachers' attitudes on history of science matters do not necessarily correspond to relevant educational practices (Lederman 2007). The dissemination of these practices confronts significant obstacles. One of them, according to Hottecke & Silva (2010), is teachers' negative attitudes to every change on the traditional teaching culture, not only because they consider HPS an additional teaching object, but also because their epistemological views are fundamentally different from views that support the introduction of elements of HPS in science teaching. Moreover, "besides attitudes and beliefs towards HPS, it is relevant to discuss the skills needed to conduct activities and classes that favor an adequate learning of NoS or concepts with an HPS approach" (Hottecke & Silva 2010). In other words, in order to introduce elements of HPS in their teaching, teachers not only have to develop positive attitudes towards HPS teaching approaches, but to change their attitude towards the traditional science teaching, since they have to handle narrative approaches and to direct class discussions on relevant questions. Furthermore, teachers appear to ask for historical material which is properly transformed for teaching (Beaufils, Maurines & Chapuis 2010). According to Monk & Osborne (1997), "the history of the science will only be adopted by teachers if there is at hand material that is brief and easily assimilable" (p. 417). Martinand (1993) suggests that we have to focus on the practical conditions and the educational means for an effective integration of HPS in teaching.
In order to implement epistemologically valid and educationally effective HPS teaching sequences, it seems that actions are required both for suitable HPS teaching sequences and teachers' training programs. Additionally, science education research needs to describe and evaluate such proposals, focusing on the transformation that knowledge traded during training undergoes, in order to guide educational practice. Elements of such a research are presented in this work.

The teaching sequence in a research framework

The teaching sequence *"Teaching the simple pendulum"*, which was organized for the students of the 9th grade of the Greek schools (14-15 years old), concerns a total of four units referring to the teaching of the simple pendulum and its relation to accurate timekeeping. In the suggested approach, there is a deep exploration of the frame of the pendulum's isochronous movement and the concept of the time period (Dossis & Koliopoulos 2005). The linkage between the simple pendulum and the mechanisms of timekeeping enhances the cultural aspect of scientific knowledge while it gives meaning to the study of the conceptual and methodological aspects of knowledge (Koliopoulos, Dossis & Stamoulis 2007).
This rationale is served by the introduction of three short texts (stories) into teaching, that include elements from the history of science. The first text is a simplified technical description of the first pendulum clock, focusing on the pendulum's role in time-keeping. The second is an extract from Galileo and concerns the isochronous movement of the pendulum (Galileo 1978). The third describes the discovery of the astronomer Jean Richer, and the discussion on the proper length of the pendulum for counting seconds (Matthews 2000). These stories are not decorative but functional elements of the teaching sequence. They are tightly interwoven with the teaching activities, since they are accompanied by questions and activities (e.g. real and virtual experiments), (Koliopoulos, Dosis & Kanderakis 2010). All work-

sheets and evaluation tools can be found in http://hipst.eled.auth.gr (HIPSTWIKI → hipst developed cases → Partner 3 Aristotle University of Thessaloniki).

The training procedure

In order to disseminate this teaching program, a seminar was organized for the science teachers of a certain educational district of Athens, where the program and its philosophy were presented. Additionally, the aims and the objectives to introduce elements of history of science in science teaching were presented, as well as certain cases of using history of science in science education. Afterwards, a workshop was offered to the three teachers who volunteered to implement the teaching sequence to their classes, and the details of the certain program were analytically discussed.

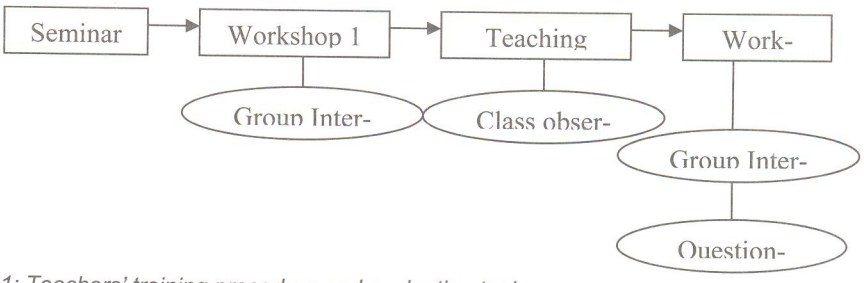

Figure 1: Teachers' training procedure and evaluation tools

Finally, there was a second workshop, and the various aspects and problems of the teaching sequence were discussed. The implemented teachings were observed by members of the research group, whereas the teachers accomplished a post-questionnaire to present their attitudes toward the teaching sequence. Teachers were asked to evaluate the training procedure, the teaching material, and the whole teaching sequence. They were also asked if their attitudes towards teaching in general, and towards the significance of history of science, have changed. In both workshops teachers were interviewed and their attitudes were recorded. The whole training procedure and the evaluation tools are shown in *figure 1*.

Evaluating the teaching sequence in the implementation framework

The teaching sequence was taught to 63 students distributed in 3 classes of 3 different schools under everyday educational conditions. Some interesting results from the analysis of teachers' questionnaires and interviews are the following:

- All three teachers consider that the whole teaching sequence was satisfactory, and that children were also satisfied and participating, but they have doubts about the final cognitive outcome. Some characteristic answers are: 'Children enjoyed this teaching, but for what will remain in the end, I have many doubts', 'For children, it was something different. Children usually indifferent and inert participated a lot.'
- They appreciated the team work, the narrations, the elements of discovery, and the fact that the program was a new approach for the students. They find the teaching material useful, easy to use, motivating, and provoking interest ('Working in groups, worksheets, narratives and elements of discovery created a better climate in the classroom and students participated with interest'). On the other hand, they estimated that history of science material was a little difficult to handle, and that some students' tasks were very demanding ('It was difficult for the student to discover experimental procedures, ways of working etc.').
- Teachers believe that the teaching sequence has significant differences from usual traditional teaching. Some of them are the existence of history of science stories, students' work on texts, the elements of discovery, and the focus on the cultural aspects of knowledge. They also believe that students were more relaxed· that they didn't feel to be subjected to teacher's scrutiny ('The program gives knowledge in an easy way, and not only in physics. The cultural aspect is distinguished as a necessary element of the teaching procedure'; 'Students were more relaxed. They were feeling they were not judged').
- Teachers find their training procedure satisfactory, and all its elements useful. They confronted, however, some difficulties to run the teaching sequence. They had to learn a lot about history of science, to understand a completely new teaching approach, and to handle team work. Additionally, in order to

overcome some of the difficulties, teachers have made proposals to reformulate the teaching material ('Initially, I found difficulties with the historical context, the described events, and the participating scientists. I have confronted all these with a search in the internet'; 'I had to understand the new approach, which was something new to me, and to be informed for the whole subject (history and mechanical clock). Moreover, in order to handle team work during teaching, I had to do a good management of time').

- The program affected teachers' attitudes towards teaching. They were affected mainly by their understanding of a new method, their personal survey and study, and students' participation. Moreover, their views on the significance of history of science were positively affected, because the teaching sequence provoked students' interest, put the content in a larger context, and connected content knowledge to everyday life ('It had influenced my views significantly. With the new approach, students' participation was greater'; 'A teaching organized around history of science moves in wider context. In this program, a problem is presented, as well as the ways to confronted it, and this gives the meaning the whole thing has in life').

✓ - Teachers consider that the introduction of historical material through short stories is interesting and effective. They think, however, that these stories have to be suitably chosen and well embedded within the teaching sequence in order to drive science learning ('Texts are not enough. They have to be accompanied by worksheets, so as, from history and culture, to pass to physics'; 'The introduction of small texts catalytically provoked students' interest. Their selection, however, has to connect science to students' everyday life').

Conclusion

The above results seems to agree, more or less, to the remarks made by many researchers, as they are mentioned in Rationale, that knowledge of history and philosophy of science is not enough to introduce HPS material to teach science. It is, also, needed pedagogical knowledge in order to cope with the innovations this material demands, i.e. to handle narrative approaches, to organize and direct class discussions etc. Teachers' beliefs about teaching methods, availability and usefulness of teaching material and classroom management create problems at least of equal importance to those of teachers' beliefs on nature of science and HPS matters.

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