Pedagogical practices carried out during an in-service teachers education project: Approaching history and philosophy of science to physics teaching

Sandra Regina Teodoro Gatti[1], Roberto Nardi[2]
[1]*UNESP, Bauru, São Paulo, Brazil. School of Sciences. Education Department. Science Education Research Group. Support: CNPq - National Council for Scientific and Technological Development.*
[2]*UNESP, Bauru, São Paulo, Brazil. Associate Professor, Education Department, School of Sciences. Science Education Research Group. Support: CNPq - National Council for Scientific and Technological Development.*

E-mail: sandragatti@fc.unesp.br; nardi@fc.unesp.br

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Abstract

We report here part of a research project developed by the Science Education Research Group, titled: "Teachers' Pedagogical Practices and formative processes in Science and Mathematics Education" which main goal is the development of coordinated research that can generate a set of subsidies for a reflection on the processes of teacher training in Sciences and Mathematics Education. One of the objectives was to develop continuing education activities with Physics teachers, using the History and Philosophy of Science as conductors of the discussions and focus of teaching experiences carried out by them in the classroom. From data collected through a survey among local Science, Physics, Chemistry, Biology and Mathematics teachers in Bauru, a São Paulo State city, we developed a continuing education proposal titled "The History and Philosophy of Science in the Physics teachers' pedagogical practice", lasting 40 hours of lessons. We followed the performance of five teachers who participated in activities during the 2008 first semester and were teaching Physics at High School level. They designed proposals for short courses, taking into consideration aspects of History and Philosophy of Science and students' alternative conceptions. Short courses were applied in real classrooms situations and accompanied by reflection meetings. This is a qualitative research, and treatment of data collected was based on content analysis, according to Bardin [1].

Keywords: Physics teaching; History of Science; Philosophy of Science; In-service teachers' education.

Resumen

Presentamos aquí parte de un proyecto de investigación desarrollado por el Grupo de Investigación de la Enseñanza de las Ciencias, titulado: "Prácticas pedagógicas y los procesos de formación del personal docente en Enseñanza de las Ciencias y Matemática", cuyo objetivo principal es el desarrollo de la investigación coordinada, que generaría un conjunto de elementos para la reflexión sobre los procesos de formación del profesorado en ciencias y enseñanza de las matemáticas. El objetivo fue desarrollar actividades de educación continua con los profesores de Física, con la Historia y Filosofía de la Ciencia como conductores de los debates y de experiencias llevados a cabo por ellos en el aula. Para eso, a partir de los resultados de una encuesta sobre el perfil de los profesores de ciencias, Física, Química, Biología y Matemáticas en Bauru, una ciudad del Estado de São Paulo, se desarrolló un curso de educación continua "Historia y Filosofía de la Ciencia en la enseñanza de los profesores de la física ", que duro 40 horas de clases. Seguimos el desarrollo de cinco profesores que participaron en las actividades durante el primer semestre de 2008 y que estaban trabajando en la disciplina de la física de secundaria. Los profesores, a partir de las reflexiones, realizaran propuestas de cursos de corta duración, teniendo en cuenta los aspectos de la Historia y Filosofía de la Ciencia en la educación, además de las concepciones alternativas de los estudiantes. Los cursos de corta duración se aplicaron en situaciones reales de aulas y el seguimiento en las reuniones de 'brainstorming'. Se trata de una investigación cualitativa, y el tratamiento de la información obtenida fue fundado en el análisis de contenido según Bardin (1994).

Palabras clave: Enseñanza de la Física, Historia de la Ciencia, La formación del profesorado en servicio.

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I. INTRODUCTION

When we discusses the gap between innovative proposals, results of investigations in Science Education and the concrete actions undertaken in classroom, a question arises: why the impact of the research is not felt to improve the quality of education in schools?

One of the possible ways to try to answer this question brings us back to teacher training. The initial training courses and continuing education have not, in most cases, achieved significant progress, mainly by disregarding the fact that teachers have preconceptions about what is important to teach, how to do it, what causes the failure of students etc. [2].

Many studies [2, 3, 4, 5, 6, 7, 8, among others] have shown the existence and persistence of traditional conceptions that teachers have on science and on the processes of teaching and learning, and discuss their influence on teaching practice.

Other problems and difficulties have also been implicated in the training courses for teachers, for example, the dissociation between training in science content and nature of its teaching, revealing that the training is limited in most cases, to the sum of education and scientific contents, completely unrelated.

Moreover, the separation between researchers who propose innovative projects and teachers as mere consumers can modify their performance by adapting to the proposals.

The transition to practice consistent with new paradigms requires a discussion of the teaching and learning processes [9], because the traditional model, as a paradigmatic system of concepts and beliefs, behaviors and attitudes, has a certain consistency and provides answers to most educational problems [10].

Marcelo Garcia [11] revels that we can not expect that the initial teachers' education offers a final product, but it should be understood as a first time for a formation that extends. In this sense it is imperative for teachers to engage in continuous process of formation.

Thus, we performed continuous training activities with physics teachers searching to approaching the History and Philosophy of Science as strands of discussions and focus of student experiments conducted by them in the classroom, allowing teachers seeking to build alternative ways to observe and understand students' work, placing them as producers of knowledge, rather than mere consumers.

The research was conducted during the 2008 school year and sought to understand whether a teaching experience focused on the integration of History and Philosophy of Science in education, taking into account that teachers' teaching views, experiences and beliefs could contribute to the acceptance of new teaching methodologies.

II. THE RESEARCH

From the results of a survey on the profile of science, Physics, Chemistry, Biology and Mathematics teachers from the city of Bauru, São Paulo State, Brazil, we elaborated a proposal of in-service teachers' education course titled "History and Philosophy of Science in physics teachers teaching practice" lasting 40 classroom hours.

We followed the performance of five teachers who attended the course during the first semester of 2008 and who were working at High School level. Only two of them were graduated in physics.

The teachers, from the final considerations made, developed proposals for short courses taking into consideration aspects of History and Philosophy of Science in education, in addition to students' alternative conceptions. The courses were developed by them in real classroom and followed by reflections meetings. This is a qualitative research and the data collected treatment was based on content analysis, according to Bardin [1].

The initial survey conducted not only revealed the profile of the teachers, but also tried to search among the participants, how the university could collaborate with their training and their teaching practice.

The necessity of providing courses was mentioned by eleven of twenty-two teachers. Some examples:

Offering training courses and support in the classroom.

With partnerships in continuing education; offering workshops to show the researches that the program has been developing.

With free courses offered at times that we could attend and giving certificates for our career development.

Based on information obtained from questionnaires, we contacted the teachers by e-mail, sending them an invitation to attend the course. We also contacted all the city secondary schools teachers via e-mail, telephone call and, in some cases, personally, in order to publicize the course that was developed in accordance with the following syllabus:

1. The theories of physics teaching and learning: a constructivist approach to teaching.
2. Philosophy, History of Science and Physics Education 3. Recent research on physics teaching.
4. Teacher and his/her professionalism.
5. Educational activities design.

The training model suggested by the use of a course, presents according to Bell [in 11] the following advantages:

1. It can increase knowledge;
2. It improves skills;
3. It provides moments for reflection on professional practice, among others.

It's important to say that our proposed training is not about developing a tight, overly theoretical and without any concern for practical applications. The course was considered only as a starting point and classroom activities were complemented by practical activities developed in real situations at High School.

Of the twenty-two teachers interviewed, seven were enrolled in the course; however, only five of them attended all activities during the first semester of 2008.

The proposal for short course, impressions and reflections on the results of its application at High School classrooms.

We present here the analysis of a mini-course designed by one of the teachers. The proposal was designed in order to incorporate the discussions held during the course, such as the approximation of History and Philosophy of Science to the Science Education, Science, Technology, Society and Environment, in addition to students' alternative conceptions about the chosen topic.

With this aim, we initially present here a synthesis of participants' lesson plan, including a discussion of the proposal suggested by the teacher and what she really developed, its justifications and impressions displayed on the mini-workshop for presentation and discussion of the results of the experiment developed.

Tatiana's short course:

The teacher seemed to have incorporated in her planning some of the innovations discussed during the training course. The proposal was concerned with students´ alternative conceptions, the approach of History and Philosophy of Science and the relations between Science, Technology, Society and Environment. The short course began with teacher's explanation of students' alternative conceptions on the subject "gravitational attraction". The questionnaire contained questions based on science education research literature. In her presentation, after the implementation of the proposal, Tatiana reveals:

In that task we did in the middle of the course, asking students to answer questions about force and motion, I had been impressed with the answers [...] Here was not different. What makes us frustrated is that I really wanted to eliminate the conceptions to which they learned science.

This teacher's speech should be contextualized. The subject, gravitational attraction, was chosen because she had already worked it during the High School first two months students. Her choice for Newton's laws was motivated by the texts worked on during the course.

Thus, the application of the developed proposal represented a kind of reinforcement of the theme. Contrary to her expectations, many initial conceptions were still present in the students' final reports.

Table I seeks to synthesize the ideas suggested by the teacher.

Regarding the approximation of the History of Science to the teaching, the planning was developed in order to demonstrate concepts evolution in the history, in addition to showing students former concepts developed, some of them similar to the views held by students.

The approach to philosophy of science was worked by the teacher, in trying to focus the question of models and the construction of knowledge.

I thought it was a gain for them, since I could argue that science is under construction. Many students were surprised because, to them, the science deals with truths that will never change.

TABLE I. Tatiana's short course design synthesis.

Tatiana		
High School first year		
NEWTON'S LAWS		
Activity Developed	**Goals**	**Evaluation**
Questionnaire to collect students' conceptions.	Assess students' alternative conceptions on the subject.	Individual questions.
Expositive class with discussion of concepts through the use of a text produced by the teacher, using the overhead projector.	Raising awareness about the issue. Demonstrate the evolution of concepts.	
Expositive class using the projector.Discussion in groups on the question: why bodies fall on the surface of the Earth but the Moon, even being attracted by the gravitational pull, keeps in Earth orbit? Definition of Newton's Laws.	Prepare the student to properly apply the the fundamental laws equations in solving problems. Discuss students' conceptions, seeking an evolution. Check the conceptual evolution.	Individual questions.

Not all planned activities designed could be completed. For lacking of time available, the last part, referring to the studies on artificial satellites and on the safety belt, planned by the teacher in order to discuss issues related to science, technology, society and environment, could not be addressed.

That was due, also, to the fact that Tatiana needed to give continuity in the teaching of compulsory subjects contained in the called "notebook" (São Paulo State Curriculum).

Nevertheless, the initial part of the designed planning was respected. The teachers' developed work was stressed on participatory lectures, with the inclusion of a group discussion activity.

The assessment of student learning took into account the results from questionnaires on alternative conceptions as well as the participation in discussions and resolution of individual tasks during the last class.

Tatiana said that:

[...] In my practice I evaluate students at various times. Then, students' grade is not [taken] only from the written tests, but also participation in all classes in various activities. Wherever possible I try to see if it is evolving.

When asked during the final seminar on the possibility of incorporating innovations in everyday practice, Tatiana understand that it is difficult for an in-service teacher to prepare and implement the lessons as they were developed during the training course.

[...] I still did not succeed in doing my practice redesigning my way to work in order to discuss these issues in every class. We have to follow the official proposal

because we are charged all the time about that; and to include historical and philosophical issues we delay much more.

At the end of her presentation, when asked about possible contributions of the experience developed for her training and practice, and whether she might continue to use the innovations discussed during the course, Tatiana revels:

Yes. Although it has not succeeded in putting into practice all of what it was discussed, I have reconsidered and reflected a lot about a new approach of content emphasizing the history and philosophy of science. I enjoyed learning about the concepts. It makes difference to use the "notebook" (São Paulo State Curriculum) knowing what is behind it.

III. CONCLUSIONS

The training model suggested by the use of a course, proved to be important in contributing to increasing knowledge of participants and provide moments of reflection on professional practice. The most important, however, is that our proposed training was not about developing a tight, overly theoretical and without any concern for practical applications.

The training course was only a starting point and classroom activities were complemented by practical activities developed in real situations in high school.
Some aspects deserve attention:

1) This training course was the first contact of all participants with the Philosophy of Science.

2) The discussions carried out provoked reflections about the teaching and learning of science; the traditional teaching, through presentation of contents as truths historically accumulated was questioned.

3) The activities seeking to emphasize the role of investigative teaching, such as the survey conducted by students' conceptions, with the subsequent group reflections, contributed to questioning the traditional view of teaching and learning, where teacher transmits knowledge that are incorporated by the students.

4) Despite the good results obtained in this training course and teachers' active participation in the process, the chances teachers incorporate in their teaching practice this approach are still limited by the conditions found in the local schools, such as excessive workload, overcrowded classes, pressure for full implementation of the curriculum, among others. The seminars to discuss the final results of the proposal developed in High School real situations allowed an exchange of experiences among teachers, establishing an open dialogue, where participants were able to reveal the difficulties in doing the experiment.

So, although we consider that the selected activities were appropriate and well developed, this does not guarantee permanent changes in the teaching activities of participants.

Although the teachers have pointed out the importance of the elements discussed during the training course for the science teaching and the intention of using the innovations discussed below, we have no evidence to indicate what would be the repercussions of the experience developed for their professional career

The training of teachers committed with the construction of scientific knowledge represents a great challenge, since, continuing education requires a constant effort on the reflection and improvement of teaching practice.

This leads us to recognize the importance of collaborative work between university researchers and basic school teachers and to consider the teacher not only as a technician who applies in their daily practice the theories provided in training courses, but as a professional that develops its own knowledge making confrontation of his/her practice with the professional conditions [12].

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