Problem-based learning to promote primary science teaching skills: A case study

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Abstract. We have been developing an in-service primary school teachers' training project which adopts the principle that if we intend that children perform experimental investigative learning, then teachers must undergo similar processes in training context. In this case study we present, as an example, the scientific and pedagogical training process of a teacher who has selected the topic "Saliva effects on starch digestion", which is included in the 3rd year of primary school programme. The whole training project was centred in problem-solving, based in a constructivist perspective of learning applied to teachers' training.

Subject/Problem. There was a first attempt to introduce science (Lesson Objects) in the Portuguese Primary Curriculum at the end of the I Republica (democratic political system after the Republic Revolution: 1910-1926); however this idea was later rejected by the political dictatorial regime of Salazar (1926-1974). After the democracy restoration (25th April 1974), science was again incorporated into the Primary Curriculum as part of the curricular area. In the general objectives of the actual Primary School Programme (1990), one can read that pupils must:

- "Use simple processes to know and to discover the environmental reality, assuming attitudes of permanent research and experimentation."
- "Select different information sources and use various methods for collecting and treatment of simple data."
- "Use diverse ways to communicate the information collected."

It also establishes that the teacher has the role of guiding a process by means of which the pupils will become active observers with skills of discovering, investigating, experimenting and learning". Until the middle of the 80s, primary teachers were not trained in institutions of higher education but in 'middle schools'; and science was not part of the teacher training curriculum. Since then, Universities and Polytechnics have been responsible for training primary teachers. Theoretically, this political decision would imply that science education researchers should supervise primary science teachers' initial training. However, as preservice teachers' training occurs in primary schools under little university supervision, the student teachers are rapidly merged into the traditional way of teaching installed in schools (Sá & Carvalho, 1997a). Hence, we have now a paradoxical situation: science is reinforced in the latest primary curricular reform (1990), but teachers continue the traditional way of teaching. It is under this overall situation that we have been developing an in-service primary school teacher training project under the following principle: if we wish that children carry out experimental-investigative learning, then teachers must undergo similar process in training context (Sá & Carvalho, 1997b). The main objectives of this teacher training project are the following: to promote teachers' skills (a) in experimental science, (b) in experimental science teaching and (c) in methodologies of observing and analysing their own teaching, in order to promote reflective teaching.

Design and Procedure. A group of fifteen in-service primary school teachers were supervised by University science researchers/educators in both general group
sessions and individual teacher-supervisor sessions. After their training at the University, each teacher guided his/her school children to carry out science activities similar to the ones previously performed by him/herself. General group sessions were organised in order to make primary school teachers familiar with the concept of experimental science teaching. Different forms of teaching experimental activities were shown by demonstration of simple examples which were further discussed in the context of science teaching. Further group sessions were devoted to a general discussion of how to plan, organise and manage a complete investigation to be carried out by the teacher him/herself, first at the University laboratory, and afterwards with his/her school children (Harlen, 1984; Sá, 1994). Methods of collecting information about the class intervention were discussed, including teachers’ diaries (Delano, 1993; Zabala, 1994) and video recording (Erickson, 1989) as well as children’s reports (Harlen, 1992; Sá, 1998). Teachers were trained in action-research methods in order to be able to analyse their own intervention and write their research reports. General objectives, strategies used and overall results of this project have been a matter of previous reports (Sá et al., 1997; Sá et al., 1998). In this paper we present a case study of an in-service teacher’s training who has selected the topic “The effects of saliva in starch digestion” which is included in the 3rd school year (8-9 years) programme. The teacher carried out her experimental-investigative activity in order to solve the following problems: i) how to identify the starch in food stuff? ii) how to demonstrate that saliva digests starch? iii) how to quantify saliva activity of different individuals?

Two goals were clarified from the beginning of her individual project: a) the improvement of her scientific knowledge and b) the improvement of her pedagogical skills to promote in her pupils processes of experimental-constructivist learning. In this communication we give special attention to the teacher’s training process.

Data analysis and findings. The interpretative analysis of teacher’s training process was based on: a) notes taken by the supervisor, b) plans of experimental activities suggested by the teacher, c) teacher’s data and data handling, d) video recording of teacher’s experimental activities, d) teacher’s final report (Ferreira, 1997), and e) oral communication presented by the teacher (Ferreira et al., 1998). The analysis of teacher’s experimental-investigative training was based on Gott et al. (1995) model for science investigation in which “concepts of evidence” is used to distinguish conceptual and procedural understanding from simple manipulative connotations of scientific “skills”. In our case study several examples of concepts of evidence could be associated with:

- **design** – understanding the idea of independent variable (e.g., saliva from different donors), dependent variable (e.g., diameter of starch digestion by saliva) and control variable (water instead of saliva); understanding the significance of an appropriate sample size (e.g., 24 saliva donors);
- **measurement** – understanding the need to select sensible values (e.g., appropriate standard curve) so that measurements of the dependent variable (e.g., diameter of starch digestion by saliva) result meaningful;
- **data handling and interpretation** – understanding that there is a close link between graphical representation and the type of variable they are to represent: line chart for a continuous variable (e.g., standard curve graph);
- **valid and reliable inferences** – understanding that one must always ask him/herself if the evidence is *believable* and if it is the solution for the problem
(e.g., does the different diameters of starch digestion correspond to the differences of individuals' saliva activity?). The present teacher's training project was based on the principle that the student-teacher encountered the problems first — i) how to identify the starch in food staff? ii) how to demonstrate that saliva digests starch? iii) how to quantity saliva activity of different individuals? — and her learning took place in respect to her attempts in solving problems. Like Peterson & Treagust (1998) we assume that the resulting learning from solving a problem is more important than the solution itself.

References.
Sá, J. & Carvalho, G.S. (1997b) Ensino Experimental das Ciências - Definir uma estratégia para o 1º Ciclo, Bezerra Editora, Braga.
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