

Students from a secondary school in Portugal ‘work as scientists’ – an experience in water and soil pollution

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1. Introduction

If we want students motivated to science we need enthusiastic teachers, who understand actual scientific research, prepared to promote development of scientific inquiry skills in their students. There have been some reports that refer to successful experiences to promote those competences when teachers and students collaborate in research projects (1,2,3). But is it possible to address, in school science, problems characteristic of actual science? This study refers to an experience where sixteen students and their teacher study a problem of soil and water pollution, caused by pesticides, in collaboration with a scientific laboratory.

2. Objectives

To transfer to a pedagogical context an authentic research experience.

3. Sample

Sixteen 10th grade students, from a secondary school in Trofa (north of Portugal).



4. Methodology

The study has been developed in two parts. In the first part the teacher integrated a research team in a scientific laboratory and studied the interaction of a pesticide with fulvic acids (a fraction of soil organic material). She implemented an experimental technique based in a sequence of extraction processes and in an UV spectrophotometric technique. In the second part she transferred the study of this problem to a pedagogical context when teaching about ‘solutions’ and ‘unitary operations’. Teaching was developed in several stages as presented in diagram 1.

Action/research was the methodology used by the teacher to evaluate teaching and learning all along. Data were collected through observation of students working, written students’ work, debates, questionnaires and individual interviews (at the end of the process to evaluate student’ appreciation of the experience).

Stage 1 – Familiarization with the theme ‘Pesticides’
Bibliography search and analysis oriented by questions previously presented by the teacher.



Stage 2 – Student’s written work about ‘Pesticides’
Students worked in groups to elaborate a written work oriented by the questions previously presented.



Stage 3 – Presentation and debate
A debate was organized where group works were presented and discussed.



Stage 4 – Establishment of a problem to be solved experimentally
The teacher proposed a problem with two parcelled questions:
Q - Is there any interaction between the pesticide PCP with water for consumption?
Q1- The dissolution of fulvic acids in water increases the solubility of the pesticide in water?
Q2- A larger concentration of fulvic acids dissolved in water increases the solubility of pesticide in water?



Stage 5 – Planning experimental work
Students, in groups, planned experimental activities to answer the problems presented. Plans were presented and discussed by the whole group (teacher and students) and a protocol was constructed to be followed by all groups, so that experiments could be repeated and results could be compared.



Stage 6 – Development of experimental work
The activities were developed and data obtained. Some data obtained in the scientific laboratory were added to student’ data, which were interpreted by the students. Conclusions were withdrawn from results, which were compared and discussed in a debate organized with that aim.



Etapa 7 – Evaluation
- Evaluation of student’s learning (content and scientific processes).
- Student’s appreciation of the experience.
- Teacher’s appreciation of the experience.

Diagram 1



Conclusions

It was possible to transfer a research work to a teaching context in secondary curriculum. The theme (water pollution) is relevant to daily life and interested students.

The collaboration with the scientific laboratory motivated the students. They could do some of the experiments and were motivated to use and interpret some data obtained, with more sophisticated equipment, in the scientific laboratory. Students learned about ‘solutions’ and ‘unitary operations’ as they were working on a problem that interested them. On the other hand they were working as ‘scientists’ as they asked questions, did bibliography research, learned new techniques, used new scientific vocabulary, planned experiments, designed protocols, developed the experiments, analysed data, presented and discussed results, compared their results with others’ results.

The teacher developed a valuable research work that is being prepared to be submitted to a scientific journal. Participating in a research team immersed her in the culture of science. It also improved her confidence. She has written: ‘my experience as a researcher enriched me not only because I developed many new competencies, but also because I was able to overcome many difficulties that looked to me, at the beginning, as huge difficulties.

May be it could be possible to develop programs in Portugal that gave opportunity to teachers to be involved, at least once in their professional lives, in experiences like this.

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