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THE "ROUTE OF THE OVAR TILE": A CONTEXT FOR TRAINING GEOSCIENCES TEACHERS

A "ROTA DO AZULEJO DE OVAR": UM CONTEXTO PARA A FORMAÇÃO DE PROFESSORES DE GEOCIÊNCIAS

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Abstract – Urban space is an outside classroom environment recognized by researchers and teachers as a very much appropriate setting for learning. When a cultural dimension is developed at this environment, this may promote curricular content approaches and reinforce the articulation of Science-Technology-Society (STS). This can promote, for example, urban heritage. This teacher education program focus on tiles covering the front wall of the buildings at the town of Ovar, in the northern part of Portugal as the core of the program. The raw materials, manufacture, application, conservation and restoration techniques were part of the project, that has been designed, implemented and assessed. The program emphasized the role played by interdisciplinary in science education, the potential of diversity of learning environments - the classroom, the streets and squares, the visits to companies and to a School of Arts and Crafts - and the information provided by different professionals involved. Twenty-one teachers of Physics/Chemistry and Biology/Geology were selected as the target audience. This presentation intends to discuss the main issues related to design and implementation of this education program. The assessment carried out by the trainees reveals important indicators.

Keywords – Teacher training, Geoscience education, Tile heritage, Interdisciplinary.

Thematic line – Education, Teaching of Geoscience and Teacher Training.

1 Introduction

This paper aims to report and evaluate an interdisciplinary experience – in-service teacher education programme – developed with Geology and Chemistry teachers that was carried out in Portugal, in 2016. The study lasted 25 hours, within a Science-Technology-Society (STS) context. Taking into account the relevance of the teachers' preparation level the authors wrote a first section overview about teacher education. A second one related to the description of the concrete case under analysis, *i.e.*, the use of tiles covering the front wall of buildings in a city in northern Portugal. The last section examines the impact of the interdisciplinary experience on teachers' preparation.

2 Teachers professional development

Due to the interaction between school and society, teachers are involved in a role essentially oriented to the personal and social development of each student: "teachers can be true social agents, planners and managers of teaching-learning" (Benedito & Imbernón 2000, p.75).

Research and reflection on practice are therefore two decisive factors that drive the professional success of the teacher and the effective learning of the students. Benedito & Imbernón (2000) defined professional development, according to a specific perspective of the teaching activity, as "a systematic interaction of improving the professional practice and professional knowledge of the teacher, in order to increase the quality of his [or her] work" (p. 43). Personal and professional development implies growth, change, improvement and adequacy, with regard to own knowledge as well as attitudes at work and to work.

Imbernón (2011) argues that a good teacher should be defined by a set of general qualities: *i*) high level of autonomous capacity; *ii*) diagnosing the development and learning rhythm; *iii*) striking ability to balance between understanding and observing individual differences in the class; *iv*) knowing how to diagnose the situation of the class; *v*) knowing how to diagnose the requirements of disciplinary and interdisciplinary academic knowledge; *vi*) ability to incorporate social issues into educational programs; *vii*) knowing how to diagnose peculiarities of educational processes; *viii*) knowing how to diagnose the situation of each student.

According to recent contributions of cognitive psychology, neuroeducation, new philosophy of science and science education, the teacher must know and put into practice the theories and proposals of these areas in order to develop processes of meaningful learning, fostering intrinsic motivation, enthusiasm and commitment of the student in the permanent learning and construction of meanings. This type of work involves contrasting with other colleagues: ideas, observations, results, problems and concerns and developing an in-depth reflection about the work done. Some authors criticize the view of the professionalism of the teacher, denying it, whilst others advocate it. Apple (1986) warns that abuse of the concept of professionalism in teaching may lead to a process of time-consuming technicality and that the gradual increase in impoverishment of teachers may be wrongly identified as a symbol of the growth of professionalism. In the same way, Popkewitz (1990) draws attention to the risk of professionalism leading to a depoliticized and technocratic view of teachers' own work. The same author also recalled that some bureaucracy and loss of autonomy by teachers, diminishing their social participation in education, are a consequence of the processes of professionalization used to introduce rationalization in educational systems.

Recalling the ideas of Schön (1987), a model of the reflexive professional is proposed, based on a reflexive triangulation: *i*) knowledge in action; *ii*) reflection in and during the action; and *iii*) reflection about action and about reflection in action. In the model of the reflexive professional, recommended by Schön (1987), the student learns with the guidance of an experienced teacher. This is a crucial question: experienced teachers and mentors help future teachers to build new knowledge through a process that Schön (1987) called "reflection on reflection in action". It is a process that refers to the metacognitive ability of teachers to cooperate with future teachers to think about their own reflection in action, that is, to express the thoughts that guide their actions and to evaluate whether or not they are appropriate. Feeling like a member of the teaching class, and being able to use the available resources of the profession itself is the great challenge. The teaching recommended by Schön produces "practical situations", low risk actions, where the future teacher can learn by doing things and receiving abundant feedback, through a transaction between senior teacher-future teacher. The teacher's role should be contributory for developing a "reflexive conversation" about the expe-

riences of future teachers. Ortega (1990) has argued that characteristic elements of the current profile of the teaching profession are the theoretical and ideological definition of teaching action, the structure of the profession and the expectations and social values of the functions that compete with the teacher. Based on the identification of the functions that the teacher must fulfil, Ortega (1990) considered that teaching leaves the professional competence reserved to the subject that educates, to assume as a responsibility shared by institutions and various educational agents. According to Ortega (1990), this generates a general distrust of some practices and some actors, and it is necessary to change the scenario, especially at the level of the teacher's self-image, for which he advocates six measures, as follows: *i*) to create a new professional mentality that does away with fundamentalisms, adjusting a little more to reality; *ii*) to radically change initial teacher education; *iii*) to approve the academic level for all teachers of higher education; *iv*) to ensure that public opinion is modified for improving the teaching profession and its importance; *v*) to fulfil cultural content, relating it to social interests and concerns; *vi*) to increase concern about knowledge and intellectual development.

Continuing teacher training is therefore a structuring element in their professional development, requiring innovative formulations to respond to the specific characteristics of the profession (Lupián & Martín 2016).

Perrenoud (2000) proposed an inventory of competencies that contribute to redefine the teaching activity, as guidelines, adopted in Geneva in 1996 for continuous formation, defining that the teacher should be the one who administers its own continuous formation. The specificity of continuous training is to reflect on what has been done and not so much about what is going to be done or about what should be done. Roth (1989) presented a set of criteria as a reflection of the processes of teachers' reflective practice.

The notion of reflective teacher leads to a new conceptual framework in the form of understanding formation and, at the same time, changes the dialectic theory-practice: (1) question what, why and how to do it; (ask yourself what, why and how others do); (2) emphasize research as a means of learning; (3) do not make judgment (wait until you have enough data or self-assessment); (4) search for alternatives; (5) keep an open mind; (6) compare and contrast; (7) find theoretical basis of reasoning, conduct, methods, techniques, programmes; (8) observe from several perspectives; (9) identify and experience progress made (own or others); (to seek uncertainties in conflict; (10) situate yourself in different contexts; (11) enquire; (12) ask others for ideas and points of view; (13) adapt and adjust to instability and change; (14) work with uncertainty, complexity and variety; (15) formulate hypotheses; (16) consider consequences; (17) validate what is given or believed; (18) synthesize and contrast; (19) seek to identify and solve problems ("problem situation", "problem solving"); (20) act after considering alternatives; (21) analyse: "what makes it work" and "what would work in what con-

text?"; (22) evaluate: "what worked? What did not work? What is the cause?"; (23) use prescriptive models only when the situation requires them; (24) make decisions about professional practice (knowledge generated by the use).

Training of Geosciences teachers should promote a deepening of knowledge in different themes of the sciences, particularly those specific to Geosciences, and provide teachers with teaching resources that enable them to mobilize such knowledge in the context of the classroom or other learning environments – laboratory or learning environments outside the classroom (LEOtC) (Clark & Carpenter 2006, Pecore et al. 2007), as well as to integrate interdisciplinary approaches in topics relevant to students. It is based on this framework that teacher training is developed in the present study.

3 Practical case: "The houses facade titles in Ovar (Portugal)"

In this section we will start to make a brief characterization of the tile heritage of Ovar city and the context that framed the training programme. Next, we present the training programme, the objectives and methodology adopted and, finally, the impact of the training on the participating teachers.

3.1 The facade tiles in Ovar

Ovar is a small Portuguese city, with about 30,000 inhabitants, located in Aveiro, in the sub-region of Baixo Vouga (Region of Aveiro). It is the seat of a municipality. It is known as the city-museum of the tile, since most of the facades of the houses of the urban centre are decorated by a great variety of traditional tiles (Figure 1), contributing to its valuable urban heritage.

According to Ferreira (2009), there seems to be a relationship between the high emigration rate of the population of the municipality of Ovar to Brazil (from the second half of the nineteenth century) and the tiling of the buildings of the city. The facade tile, although known in Portugal in the first half of the nineteenth century, was little used or appreciated, unlike what had already appeared in Brazil, where it was used as an element of civil architecture. Thus, the commercial exchanges with Brazil and the return of Portuguese emigrants to their country, in the third quarter of the nineteenth century, should have contributed to the use of the facade tile on buildings and dwelling houses of this region and, therefore, the increasing number of ceramic factories in the northern region of Portugal (Porto and Vila Nova de Gaia).



Figure 1. Examples of facade tiles from the urban center of Ovar.

The richness of the tile heritage of Ovar led the municipality to create, in the year 2000, a Conservatory and Restoration of the Tile (ACRA), with the purpose of reserving the built heritage and investing in the divulgation of its heritage, creating the "Route of the Tile of Ovar".

3.2 The training program

The training course: "Interdisciplinarity in Experimental Sciences in a STS perspective" lasted 25 hours and was developed by two teacher trainers, who were also Department Coordinators – one of Biology / Geology and another of Physics / Chemistry. The course was attended by 21 teachers of Biology / Geology and of Physics / Chemistry of different schools of the Aveiro region. The training course was intended to contribute to a deep reflection of the trainees on the STS perspective in the sciences teaching and to promote interdisciplinarity in experimental science classes.

The way in which this training course was structured and the presentation of a great diversity of scientific and didactic foundations was intended to contribute to a reflection of the trainees about their role in promoting approaches using STS perspectives on favourable contexts for student learning. Situated near the schools, the studied places help to promote interdisciplinarity and the sessions were concealed in a formative context emphasizing teamwork as recommended by Korthagen (2010) and Sá-Chaves (2011). STS orientation allows the integration of the social dimension of science and technology in the teaching of science, as a connection between science and the real world. It also allows a better understanding of the nature of science and technoscience (Acevedo Díaz 2004). These are the reasons "The Ovar Tile Route" was selected as a training context. The framework was familiar to the trainees and was easy to adapt to the educational context, allowing an approach to experimental sciences from an interdisciplinary perspective.

Besides Department coordinators, the training was attended by trainers with different academic and professional experiences (two restoration technicians, a collaborator of a kaolin exploration). It was considered that the "look" of these technicians on the scientific contents could be an added value in the teachers training (Sá-Chaves 2011), in order to promote a better articulation between the experimental sciences (Geology, Biology, Chemistry and Physics), technology and society.

The training programme took place during six sessions, articulated among themselves, in which diverse contents were approached and different training environments were used (exploration of kaolin, School of Arts and Crafts, streets of the city of Ovar, classroom). The methodologies adopted are based on a reflexive practice of critical orientation and contemplated diverse activities, carried out in a small group and in plenary.

Table I presents the contents explored in each of the training sessions, their duration and participants.

Similar to what is expected for the students, the visits made to kaolin exploration (Figs. 2 and 3) and the School of Arts and Crafts (Figs. 4 and 5) were guided by the visit script, preceded by a preparation in which the objectives of the visit, the methodology to be adopted and the place to be visited were presented and discussed. A reflection on the lived experiences was then constructed. The visits sought to provide a training environment that would enable trainees to:

- Know the perspectives, knowledge and experiences of specialists with different backgrounds;
- Deepen scientific, technical and technological knowledge associated with the exploitation of geological resources and their social and environmental implications,

Table 1 - Contents and trainers per training session

Sessions	Trainers	Training contents
1. st session (5 hours)	Department coordinators	<ul style="list-style-type: none"> • Didactic conceptualization underlying the programs / curricular goals of the subjects of Biology and Geology and Physics and Chemistry. • Practical activities and skills development. • Exploration and treatment of geological resources: preparation of a visit to a kaolin exploration.
2. nd session (4 hours)	Collaborator of a kaolin exploration	<ul style="list-style-type: none"> • Exploration and treatment of geological resources: visit to the kaolin exploration in São Vicente Pereira Jusã (Ovar).
3. rd session (4 hours)	Department coordinators	<ul style="list-style-type: none"> • Reflection on the pertinence of the visited place and the information gathered for the curricular approach of contents of sciences. • Kaolin: social importance and educational potential. • Geological resources in the construction and ornamentation of buildings. • Visit script presentation and discussion "Learning sciences in the Tile Route".
4. th session (4 hours)	Restoration technician	<ul style="list-style-type: none"> • Visit to the School of Arts and Crafts of Ovar: raw materials used in the facade tiles; social and historical framework; anomalies and main causes; conservation and restoration.
5. th session (4 hours)	Department coordinators	<ul style="list-style-type: none"> • Visit to the "Ovar Tile Route" to discuss the educational potential and feasibility of the script "Learning sciences in the Tile Route".
6. th session (4 hours)	Department coordinators	<ul style="list-style-type: none"> • Reflection and discussion on the pertinence of the places visited and the information gathered for the curricular approach of science contents.

- Relate such knowledge to the conservation and restoration of traditional facade tiles.

3.3 Impact of training

The trainees elaborated, following the proposals of Roth (1989), for the processes of reflective practice of the teachers. After completing the training course they wrote their reflections and were invited to express their opinions on the following aspects: *i*) reasons of interest in the training action; *ii*) critical appraisal of the theoretical and practical aspects of the training; *iii*) work done during training; *iv*) difficulties encountered; *v*) overall appreciation of the training action. Due to the content analysis of the individual reflections elaborated by the trainees we can highlight the following points.

The visit to the "Ovar Tile Route" was aimed at discussing the educational potential and feasibility of the script presented in the third session. It also sought to reflect on procedures that might contribute to the design and implementation of STS matrix curriculum materials.



Figure 2. Kaolin extraction.



Figure 3. Kaolin treatment unit.

Concerning the reasons for interest in the training action, most of the trainees reported that they lagged in the acquisition of scientific and didactic knowledge that would help teachers to value collaborative work, interdisciplinarity, practical work, learning in context and STS perspectives. The aim was to contribute to improv-

ing the quality of students' learning and helping them to exercise more active citizenship.

In the critical appraisal of the theoretical and practical aspects of the training course, we highlight: the scientific basis for how interdisciplinarity can be applied in the experimental sciences, valuing the practical work, the STS perspective and the activities in LEOtC; the visit to sites that helped to understand the aspects associated with the exploration of geological resources (visit to the São Vicente de Pereira Jusã kaolin exploration); the manufacture, construction, use and restoration of tiles (visit to the School of Arts and Crafts of Ovar) and to the knowledge of a pedestrian route in a part of the "Route of the Tiles of Ovar".



Figure 4. School of Arts and Crafts auditorium.



Figure 5. School of Arts and Crafts restoration atelier.

With regard to the work carried out during the training, the trainees highlight the topics addressed by the theoretical sessions, in which scientific contents related to the exploration of geological resources (kaolin) and to the transformation and use of them in the manufacture of tiles, as well as the preparation of the exits of field. They also highlight the dynamics implemented in the training sessions, namely the group work, the plenary discussions and the sharing and debate of ideas between the trainees and the trainers. The sharing of curricular materials by the trainers is also an aspect highly valued by the trainees.

With regard to the difficulties experienced by the trainees, they come mainly from their pedagogical practice, namely: *i*) the lack of interdisciplinary articulation and collaborative work among the trainees; and *ii*) the ignorance of curricular programmes of other disciplines than those they teach. However, most trainees are willing to change their pedagogical practices, taking into account these aspects.

In an overall assessment, the different areas of formation of the trainees - Biology, Geology, Physics and Chemistry - provided a space for joint reflection and clarification of doubts. The use of innovative curricular materials, which use the "Ovar Tile Route", is a privileged space for learning programmatic contents from different disciplines, facilitating the promotion of education for citizenship and the valorisation and preservation of these places.

It seems that the training has followed the true spirit of continuous education courses for, and with, teachers, taking into account the indicators obtained, from the way the trainees reacted along the training course and as expressed in the individual written reflections. We believe that the design and implementation of curricular materials from an interdisciplinary perspective can play a key role in teaching and learning and in promoting citizenship education.

The design and implementation of curricular materials from an interdisciplinary perspective can play a key role in teaching and learning and in promoting citizenship education. In order for this to occur, the materials must integrate diverse practical activities for different learning spaces (classroom, laboratory, LEOtC, virtual space), articulated among themselves and conceived from an STS perspective, valuing interdisciplinarity. It allows developing problem solving skills, attitudes and skills that contribute to a significant improvement in the quality of student learning.

We consider, therefore, in the line of Ortega (1990), a need for the teachers to increase concern with their knowledge and intellectual development, creating a new professional mentality, adjusting a little more to the reality. It is important that teachers continue to join continuing education courses and engage in research-action-reflection projects so that they can become aware of the need to open up new teaching and learning orientations. We advocate guidelines that value greater knowledge of the regions in which schools are integrated, who promote the study of the natural resources therein and their exploitation, processing and use. These can contribute to the implementation of activities in an interdisciplinary and STS perspective. We also consider that the interdisciplinary modality assumed in this training course, which sought to attenuate the existing disciplinary barriers between different disciplinary groups - Biology / Geology and Physics / Chemistry, should be extended to teachers of other disciplinary groups, preferably teaching in the same school.

It will also be appropriate for schools to create spaces for reflection and discussion, through the exchange of

experiences among teachers, independently of the disciplinary group, and ones that are consequent in the enrichment of the pedagogical practices of all the teachers. The spaces should also contribute to the development of scientific, disciplinary and interdisciplinary competences and didactic skills necessary to the design and implementation of new didactic materials, supported by STS perspectives. In addition they should enhance the quality of teaching and learning in all areas of knowledge, in building a better world.

The curricular materials built by the trainees, within the framework of the training, were implemented with their secondary students (12th grade). The results of the implementation of the materials are still being analysed. However, the first indicators show that the students were very involved in the accomplishment of the proposed tasks and produced works that surpassed the expectations of one of the teachers involved.

This training also had repercussions at the local community level. At the invitation of the Municipality of Ovar, the trainers' guided tours on "The sciences on the Tile Route" aimed at the general public.

4 Final considerations

Teachers realize that the training programme on "The facade tiles of houses in Ovar, Portugal" has contributed to their professional development and argue that the school management should provide conditions for the accomplishment of collaborative work, facilitating interdisciplinary evaluation in their teaching practices. These results reinforce the importance of teacher education for teachers' professional development, especially in the design of teaching materials for outside learning environments. Such curricular materials promote interactions between Geosciences, Technology and Society, even allowing the definition of a new acronym – GTS.

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