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A Field-Based Approach To Teach Geoscience: A Study With Secondary Students

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Abstract

Many geoscience fieldworks are not aligned with the curriculum contents reflecting the need to develop more research related to the outdoor learning environment. The purpose of the study was to verify if a fieldwork organized in accordance with Orion's model (1993), could be assumed as an integral part of formal school science curricula. A fieldwork has been carried with a sample of 115 secondary science students from a rural school in Portugal. A mixed research method was carried out. Short questionnaires were applied to students and to a participant observer, and the researcher wrote reports. Evidences indicated the relevance of geological fieldworks for geoscience education. This study highlighted the relevance of fieldwork as an integral component of the formal curriculum.

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Keywords: field trip; formal activity;outdoor environment; secondary students

1. Introduction

Many current science education reforms over western countries urge science students to be frequently and actively involved in exploring the natural world in order to develop inquiry activities. However, as the outdoor learning environment is not yet commonly used as an integral component of the learning process, fieldworks are generally neglected in formal education. As such, many geoscience classrooms are still centred in textbooks readings and in some practical work undertook in indoor environments (Esteves et al., 2011). Although practical work, namely modelling activities, is used to mirror scientists' activities, the field ***is*** and will always be the natural environmental to research geo-scientific issues. Nevertheless, many doubts and criticisms arise from curriculum

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designers, teachers and school directors, on this respect. Lack of time and financial constraints are the main reasons evoked. Other barrier that arises in the use of a field-based approach is the lack of teachers qualified to mediate the process, since there is insufficient knowledge related to the organization of fieldwork and the unravelling of difficulties inherent to its alignment with science syllabus objectives. In fact, literature indicates that connecting fieldwork to the classroom curriculum is an important issue to stimulate and encourage teachers to consider outdoor environment in their teaching plans (Esteves et al., 2013a; Kisiel, 2005). Within this framework, the purpose of this study was to verify whether a fieldwork, organized in accordance with Orion's model (1993), could be seized as an integral part of formal school science curricula. Given its potential contribution to the development of diverse competences directed to the conceptual knowledge comprehension and scientific reasoning, it was hoped that evidence resulting from the fieldwork would encourage curricular designers to incorporate fieldwork as a compulsory activity in geo-science teaching.

2. A model to organize fieldworks

Outdoor environment provides students with opportunities to be involved in tasks that resemble how scientists work, a requirement that is needed in almost every science syllabus. As stated previously, sometimes teachers have difficulties to overcome the organization of this kind of activities. As such, the availability of a model that helps teachers in its organization becomes fundamental. Amongst many models that may be used to organize a fieldwork, this study option resorted to Orion's model (1993), due to its simplicity and well-structured design. Furthermore, over the years research has revealed Orion's model to be a meaningful tool in the promotion of inquiry activities, group social interaction and a strong commitment between students and nature (Esteves et al., 2013b). Orions' model is herein presented as an alternative to traditional activities, which are focused both in the teacher and the information that is communicated, resorting to the natural context and phenomena only to illustrate and confirm the geological data (Lima et al., 2010). As stated by Orion (1993, 2007), the concepts to be learned in the field are classified according to their level of abstraction, and the organization has to consider three units: preparation unit (before the field trip); the field trip; and the summary unit (after the field trip). The curriculum materials developed to the fieldwork include a teacher field guide for the preparatory unit, a student's field guide directed to their individual research in each study station, and a series of mini-posters to help teachers explain observations during the group discussion that usually follows the individual investigation (Orion & Hofstein, 1994). Reducing novelty space (cognitive, psychological and geographical factors) is a priority task in the preparatory unit. The idea of novelty space emphasizes the importance of reducing to the minimum the factors that can difficult the meaningful learning during the field trip (Orion, 1993). The same author refers that the summary unit includes the more complex concepts, which demand higher abstraction competences and higher level of concentration from students. It is the unit that has to promote reconceptualization and consolidation of knowledge, as well as the emergence of new research questions. In the end of the fieldwork students much be well acquainted with the geological story of the area and they must have developed knowledge and understanding of all of the geological phenomena and processes in study. According to Orion (2007), integrating the outdoor environment as an integral and central component of the learning process is essential when considering an Earth science holistic approach that aspires to achieve the "science for all paradigm". Unfortunately, many students do not have access to such learning experiences, especially due to a lack of a challenging curriculum that incorporates out-of-school activities (Luehmann & Markowitz, 2007). Developing organized fieldwork according to a proved successful model may encourage its development among geoscience teachers.

2.1. The fieldwork carried out on River Minho's left bank

In this study a field trip has been carried out on the left bank of River Minho, with a sample of 115 secondary science students from a rural school in Portugal. The field trip included five study stations where the vast local geo-diversity could be observed and its geological aspects taught to students. The fieldwork was organized in accordance to the three units mentioned in Orions' model and specific and varied curriculum resources were built for each unit: a students' field guide, worksheet, mini-posters and PowerPoint presentations.

The preparatory unit was developed in the classroom and aimed to reduce the *novelty space* - the cognitive, psychological and geographical factors inherent to the specific outdoor environment to be visited. The aim was to minimize those factors that could generate difficulties and to create favourable conditions to the implementation of the field trip. PowerPoint presentations where used to familiarize students with the new space and its geological aspects. It was also aspired to develop motivation and interest among students. In terms of cognitive factors, this unit intended to help students to develop capacities that were deemed as necessary to perform field trip activities. For instance, students were taught how to use the compass, how to read geological maps and how to collect rock samples. Psychological factors were addressed through the explanation of the activities that were to be performed, the understanding of the work to be carried out in each study station, and the awareness of which members would be included in the same working group. At this stage, students prepared questions and raised problems to be surveyed in the different study stations, which were prearranged as a thought-path for the fieldtrip. The aim of the educational resources set for each of the study station tasks was to have students observing and collecting evidence that answered questions rose in the classroom. The final tasks involved reading geological maps, using the compass and collecting rock samples. The preparation of the field trip included the selection of the study stations, which required the evaluation of accessibility and relevance. The number and location of study stations was defined during the preparation of the field trip, which was organized with five study stations with geological aspects integrated in the curriculum. A researcher conducted the field trip. He facilitated the students' work helping them with the inquiry activities, without giving them neither the answers to the questions of the field guide or the solutions to problems arisen in the classroom. The facilitator also helped the working groups during their debates, by questioning students, stimulating their research and critical thinking. Students had an active role and where at the core of the learning process during the whole unit. In the summary unit, which took place in the classroom (indoor environment), students evaluated and thought about the activities developed during the field trip. Consolidation of knowledge occurred through the re-formulation of explanations and comparison of observations with previous knowledge. Students were directed to knowledge re-conceptualizations. The teacher helped students to formulate conclusions (based upon the resulting evidences), and to develop their critical thinking, knowledge and ability to reflect upon the field guide results.

3. Methodology

A mixed research method was carried out and data were collected through observations and questionnaires. Short questionnaires were applied to 115 students integrated in five geosciences classes, including students from the 11th grade, with ages ranging from 15–19 (average age, 16 years). The observation reports were written by a participant observer (the geoscience teacher) and by a researcher (the monitor of the fieldtrip). These instruments enabled data triangulation with descriptive statistical analysis and content analysis. The advantage of resorting to diverse techniques and instruments to collect data was the possibility to triangulate quantitative and qualitative methods enhancing the validity of the results. The validation of the short questionnaires was carried out by a panel of experts, and the reports content analysis was undertaken by two researchers with experience in qualitative analyses. The questionnaires that were applied to evaluate the preparatory and summary units had the following closed questions, which had to be answered in a 3 points Likert scale (disagree, nor agree nor disagree, agree): (q1) I was interested during the class, (q2) I raised questions / participated in the discussion to raise questions, (q3) I was focused, (q4) I was actively engaged with /in the tasks, (q5) I liked the classes, (q6) this class was helpful, (q7) teacher's explanations were clear and (q8) the classes overcame my expectations due to the relevance of the fieldtrip. Reports were written after the fieldwork, so as to verify the relevant (positive and negative) aspects of the mediation process, the difficulties of the students' engagement in the process and an overall evaluation of the model that was implemented.

4. Results

In this section results will be presented according to the instruments used to collect data. The students' answers to the short questionnaires showed that the answer to q2 (I raised questions/ participated in the discussion to raise questions) was the less positive (less that 30% answered 2 or 3), maybe because students weren't engaged nor familiarized with the procedure used in the activities integrated in the preparation unit. The answer to q4 (I was actively engaged with/ in the tasks) was the most positive (67% answered 2 or 3) which demonstrated that students were engaged in the classroom work. In the other answers the overall results were positive since the average obtained was always higher than 2 points. Students' tended to show interest, they were focused and appreciated the activities. The final activities were considered essential to the success of the fieldtrip. It should be noticed that similar results arose both in the preparatory and the summary unit. In a debate that followed the application of the questionnaires, students expressed the resulting increase in motivation, as well as pinpointed the difficulties that they had felt when performing the specific work that was included in the field trip tasks. The content analysis of the report of the teacher (which was a participant observer), corroborated the success of the fieldwork. The teacher reported that students worked collaboratively and that dynamically answered to the field guide questions. The report also mentioned that the reduction of novelty space allowed students to be more focused and to achieve objectives such as observation, sample collecting, interaction with colleagues, focusing, answering questions raised in the classroom and collecting field evidence. In this sense, students were able to learn conceptual knowledge and explore scientific processes and research capacities. At last, the teacher mentioned that the outdoor environment allowed the consolidation of knowledge and prompted students to relate theoretical information (explained in the classroom) with field observations. This task allowed them to increase the abstraction level of conceptual knowledge. Content analysis of the research report ascertained that the student's participation was positive, essentially due to the increase of motivation, interest and endeavour that was stimulated by the performance of the majority of the tasks in the overall units. It was pointed out that the mediation of the teacher (a facilitator) helped the development of collaborative work and the learning process. Is was stated that " the activity was very interesting mainly due to the exploration of geologic content resorting to local and natural resources". Nevertheless, some difficulties related to the outdoor environment were identified, such as the students' dispersion. On the other hand, the opportunity given to students to observe geological aspects *in situ*, backed by mini-posters and collaborative work, was mentioned as a positive aspect. Data triangulation performed with three instruments points to the potentialities of fieldwork in terms of promoting motivation, favouring the process of learning conceptual knowledge, developing research processes and increasing collaborative work. In relation to the preparatory unit, the reduction of the novelty space was seemed as a useful factor that favoured comprehension. The summary unit was useful to promote reconceptualization and consolidation of knowledge. The mediation of the teacher was claimed as relevant to the student's comprehension and development of the learning process.

5. Conclusions

The evidence that emerged from this study proved that the field-based approach was effective in helping students to achieve the knowledge required to fulfil the Natural Science syllabus learning objectives, as well as to develop other competences such as scientific reasoning and inquiry capacities. Although literature reveals that science enrichment programs housed outside traditional school settings offer unique opportunities to access and use authentic scientific practices, opportunities to be involved in these practices are developed only when science teachers value them (Luehmann & Markowitz, 2007). This study examined how students from five secondary science classes and their geoscience teacher evaluated a fieldwork that took place in a surrounding area from their school. Findings indicate that both participants and an external observer consider the outdoor learning environment as extremely beneficial in increasing motivation and interest, favouring meaningful knowledge and understanding. As the study offers insights into the recognition of the outdoor learning environment as a potential environment for teaching and learning geoscience, it is expected that curricular designers and educational policy makers incorporate outdoor learning environment as an integral part of formal learning of geosciences.

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Task-based language learning and teaching give students something real to do using the language they are learning. Such tasks can include visiting a doctor, planning a tour, conducting an interview. Assessment is primarily based on task outcome rather than on accuracy of prescribed language forms, therefore there is no prior focus on language. This makes TBLT especially popular for developing target language fluency and student confidence. What are the advantages of TBL? 1. The focus of the learning process moves from a teacher to students. Students themselves decide on the content of the task Student-centered learning systematically establishes the interrelation between learning, teaching and development. This is an entire educational process, substantially different from the traditional educational process [6, p. 34].Â his approach into a general theory on education. The term "student-oriented learningâ€ has also been associated with the work of Piaget and more recently with that of Malcolm Knowles [8].Â assessment, whereas consultation and study receive little attention; (b) students compare themselves to each other, which leads to the development of an emulative spirit rather than that of personal growth. Esteves, H., Fernandes, I., & Vasconcelos, C. (2014). A Field-Based Approach To Teach Geoscience: A Study With Secondary Students. Social and Behavioral Sciences, 191, 63-67.Â Many geoscience fieldworks are not aligned with the curriculum contents reflecting the need to develop more research related to the outdoor learning environment. The purpose of the study was to verify if a fieldwork organized in accordance with Orionâ€™s model (1993), could be assumed as an integral part of formal school science curricula. A fieldwork has been carried with a sample of 115 secondary science students from a rural school in Portugal. A mixed research method was carried out. Short questionnaires were applied to students and to a participant observer, and the researcher wrote reports