The Use Of Field Activities In Geology Teaching Conceptions And Representations Of Practices Of Portuguese Teachers

Luis Dourado
University of Minho, Portugal
ldourado@ie.uminho.pt

Laurinda Leite
University of Minho, Portugal
lleite@ie.uminho.pt

ABSTRACT
Field activities are valuable geology teaching resources. However, their effective educational value depends on the way teachers use them which in turn depends on teachers' conceptions. This research focused on comparing how 102 low secondary school teachers and 131 secondary school teachers deal with field activities in geology teaching. The results show that, opposite to what happens in the secondary school, the majority of low secondary school teachers do not use field activities. The majority of field activities users promote less than four activities per year and most of them do not seem to have an appropriate understanding of how field activities should be used to become a valuable educational resource. Besides, teachers do not trust too much students' ability to play an active role as learners, as they argue for teacher centred activities, based on the idea that students are not able to carry out the activity or that it is teachers' responsibility to undertake it. However, the majority of field activities users feel satisfied or even completely satisfied with the way they have been dealing with field activities. This means that teachers' conceptions and practices need to be improved.

INTRODUCTION
Science is about the natural world. Its main objective is to fully understand nature in order to attain the ultimate goal of controlling and also benefitting from it. Therefore, every citizen living in modern scientific and technological advanced societies should have a level of understanding of science that enables him/her to understand and use scientific knowledge in everyday contexts. Hence, it has been argued that whatever the school level, science teaching should give a meaningful contribution to developing students´ scientific literacy (DeBoer, 2000; Liu, 2010). This requires science teaching to convey students an understanding of some basics science concepts and a mastery of some methods and technics so that they can not only appreciate the way science knowledge is developed but also use it in their everyday personal, societal and professional lives, namely to solve real socio-scientific problems. To succeed in doing so, science teaching must not neglect developing students reasoning (Liu, 2010) and metacognitive abilities (Veenman, 2012; Thomas, 2012), so that students can decide when, what and how they can use science knowledge in those contexts and for those purposes.
It has been argued (Dillon, 2011) that teaching science outside the classroom may help students to become aware of the usefulness of science knowledge. As far as geology teaching is concerned, teaching outside the classroom is necessary also because the main geological processes can hardly be reproduced in the lab to be studied because they take a too long time to occur and have very large dimensions which are incompatible with the limited space of the laboratory (Alvarez-Suárez, 2003). Therefore, there is a good consensus among science educators and science teachers that engaging students in field activities may be a good way of getting students acquainted with real geological phenomena and to foster a contextualized and meaningful learning about them. However, the way field activities are structured and used is the key factor that may enable to or impair from reaching these goals. This is the main reason why this paper focuses on the use of field activities for geology teaching.
Due to some proliferation of terms, it seems necessary to clarify the meaning of three central concepts of this research: field wok, field activities, and field trips. Following a previous conceptual discussion on this issue (Dourado & Leite, 2013), in this paper we assume that fieldwork is a single entity that encompasses the whole set of field activities that a student can do outside the classroom. As far as field activities are concerned, they have to do with a diversity of tasks that are carried out outside the classroom: where the events to be studied take place; where the natural phenomena happen and can be observed as they happen, without the need of being reproduced; or in real work contexts, where technology is used for industry and production purposes. In addition, and as it was pointed out in a previous paper (Dourado & Leite, 2013), if one wants students to be involved into field activities, a field trip has to be planned and organized and it can include the performance of one or more field activities within the scope of one or more school subjects.
Having students doing fieldwork requires a previous preparation of the field trip. As a matter of fact, taking students out of school requires deciding on the scope and destiny of the field trip, setting up a set of administrative procedures (related, for example, to funding and transportation), and obtaining parents' permission for their children to take the trip. However, it is worth noting that doing fieldwork does not

necessarily require a long trip (Del Carmen, 1999), as some school surroundings may be rich enough to be worth being studied with the advantage of increasing the probability of making learning more meaningful for students, due to the geographical proximity of the place or phenomena that are studied.

Field trips may lead to simultaneous attainment of several learning outcomes, depending on the way they are organized, on the characteristics of the field activities to be undertaken, and on the way they are performed. As summarized in a previous paper (Dourado & Leite, 2013), those broad learning outcomes can be synthesised as follows:

- "conceptual learning, that is objectives that focus on strengthening previously acquired conceptual knowledge, constructing 'new' conceptual knowledge, or reconstructing students' conceptual knowledge (which is especially interesting when students hold alternative conceptions on the concepts to be studied within the scope of the field trip);
- procedural learning, that is knowledge of specific purposes observation techniques (e.g., birds needing), samples collection (e.g., water from a river), conservation and transportation of materials (e.g., plants or animals) that need to be mastered by students;
- epistemological learning, that is knowledge relative to the characteristics of the scientific methodology relevant in field contexts, as well as to the (un)certainty of the science explanation and to the nature and role of models in (physics, chemistry, biology and geology) knowledge development;
- attitudes development, namely those related to respect towards the environment and towards science as well as scientific attitudes;
- interpersonal relationships, which have to do with respect to others, and cooperation with colleagues;
- contact with nature and real contexts, aiming at making students' aware of the complexity of the real world and the interactions that it comprises;
- questioning abilities, that is asking questions about nature and work contexts to understand, improve and take profit from them;
- extrinsic motivation, that has to do with fostering students' interest and curiosity towards real world work contexts." (p. 1234 and 1235).

However, as it was suggested above, the learning outcomes that can be achieved through a field activity depend on the way it is structure and implemented. Thus, when planning a field trip, it is worth to start by deciding on the objectives to be attained and to select the most appropriate way of choosing and structuring the activity to be performed. According to Pedrinaci, Sequeira and García (1994), these decisions may be influenced by the teachers' teaching perspectives but they may be facilitated by having a typology of field activities that makes it explicit how different structures may be more prone to lead to the fulfilment of some objectives than to others. Based on classifications of field activities suggested by other authors (e.g., Compiani & Carneiro, 1993; Pedrinaci, Sequeira & García, 1994), Dourado and Leite (2013) have identified and characterized seven types of field activities and made explicit the outstanding objective that students may attain through each of them. Those types of activities are: Motivating, Training, Illustrative, Guided observation, Inductive, Problem posing and Problem-solving activities. Thus, the outstanding objective ranges from affective (e.g., Motivating activities) and procedural (e.g., Training activities), to conceptual (e.g., Illustrative activities) and inquiry objectives (e.g., Inductive and Problem solving activities). Some of these types of activities should be performed before approaching the related concept (e.g., Motivating, Problem posing), others should be performed after teaching the related concepts (e.g., Illustrative) and others can be performed either during or after concept teaching (e.g., Training) and still others can be really integrated with related concept as they work as starting points for learning those concepts. In fact, this requires the use of previous knowledge (that may be further developed during the activity) but also originates new learning (e.g., Problem-solving) and promotes conceptual, and methodological knowledge integration.

Although teachers believe that fieldwork provides a number of direct benefits to student's learning, they seldom use fieldwork (Morcillo, Rodrigo, Centeno & Compiani, 1998; Toro & Morcillo, 2011) and when they do "they use fieldwork as a means to help students understand theory, to inject reality into their teaching and to teach subject-specific skills." (Scott, Fuller & Gaskin, 2006, p.169). In fact, fieldwork is one of the tools that can be used to put theory into context and teachers keep on seeing fieldwork as essential for engagement with the external ('real') world (Michie; 1998; Scott, Fuller & Gaskin, 2006). However, they seem to prefer to teach the content before performing the field activity, so that students become aware of what they are going to meet in the field (Morcillo, Rodrigo, Centeno & Compiani, 1998; Scortegagna, 2005). They believe this is important for students to take the most profit from the visit. A consequence of this is that most field activities are illustrative (Zamalloa, Maguregi, Fernández, Echevarría & Sanz, 2014) even though teachers are used to state that they would like to perform more motivating and inquiry like activities, focusing on contents different from those taught in the classes (Morcillo, Rodrigo, Centeno & Compiani, 1998; Albergaria-Almeida, Barros & Cruz, 2013).

As field activities take place outside the classroom, they require a field trip to be organized and, as this costs

time and money, it should be appropriately prepared. For this purpose, three steps need to be considered: before the field trip, during the field trip and after the field trip. With regard the first step, and whatever the main goal of the field trip, bureaucratic (including permission to take students out of school) aspects need to be dealt with by the teachers and/or the school leaders. However, there are also pedagogic issues (e.g., teaching concepts, training technics, developing observation grids, making explicit assessment criteria, etc.) that need to be considered but the appropriate way of doing it (including tasks to be carried out and ways of getting students engaged) depends on the nature of the field activities to be performed during the field trip, and it may range from no task done before it (e.g., Problem-posing) to concept teaching before the field trip (e.g., Illustrative). Advantages of making students familiar with the place to be visited needs to be analysed and eventually tackled before the field trip. The encounter with a novel place may be an advantage for some types of activities (e.g., Motivating; problem posing) but it may partly prevent learning in others (e.g., Illustrative).

During the field trip, field activities should be performed according to the type of activity chosen and the requirements it imposes to students and teachers. This means that teachers need to think carefully how they will conduct students in the field, how much guidance they will offer to them, and how much verification they will do to ascertain that students did (observed or collected or measured, etc.) what they were supposed to do.

After the field trip some well-designed tasks should be undertaken in the classroom or in the laboratory to continue, complement and/or evaluate learning that took place ion the field. Students should actively participate in these tasks, so that teachers can perceive their achievements and failures related to the field activities and can help them to overcome the latter and to really take educational profit from the field trip.

Despite the existence of guidelines for field trips and field activities organization (García, 1994; López, 2008; Rebelo, Marques & Costa, 2011), when they are organized, they hardly attend to research recommendations which may put at risk the fulfilment of their intended learning outcomes. In fact, Remmena and Frøylanda (2014) studied six cases of follow-up work carried out by three teachers and their students in three upper secondary schools in Norway in order to find out whether or not it was consistent with literature guidelines. In all but one case, the implementation of such recommendations followed the literature guidelines but they concluded that students undertook low level learning processes.

Research suggests that teachers perceive field trips as highly valuable educational experiences for their students (Anderson, Kisiel & Storksdieck, 2006) and make it explicit several reasons for using field trips (Kisiel, 2005), among which are: increases students' motivation, and promotes learning (Kisiel, 2005; Viveiro & Diniz, 2009). Stokes, Magnier and Weaver (2011) even concluded that students and teachers identified similar purposes of carrying out fieldwork and emphasized that some of those purposes have to do with fragmented (non-relational) conceptions, which focus on a single piece of learning, and others concentrate on cohesive (relational) conceptions that require the development, use and integration of different types of knowledge. Zamalloa, Maguregi, Fernández, Echevarría and Sanz (2014) found that the majority of Spanish low secondary school geology teachers use pre-field activities even though these have to do with giving a lecture on the content to be approached during the visit. The option for a lecture-like pre-field trip task may be dictated by the fact that they have not ready materials that they can use to support those tasks.

Activities performed during a field trip are frequently not integrated into subsequent school-based learning, probably because teachers value and understand field trips better than post field trip activities (Anderson, Kisiel & Storksdieck, 2006). Besides, even though teachers say that they promote post field trip activities, it seem that they have different perspectives of what it should be (Kisiel, 2005) and students do not perceive that the activities they are asked to do in the classroom have some sort of relationship with the field trip (Anderson, Kisiel & Storksdieck, 2006).

When teachers try to organize a field trip they face several constraints (Anderson, Kisiel & Storksdieck, 2006; Viveiro & Diniz, 2009) that are independent of the school system and the cultural background (Anderson, Kisiel & Storksdieck, 2006). In fact, Anderson, Kisiel and Storksdieck (2006) noted that funding, lack of time allocated to field trips planning and preparation, and lack of autonomy to select venue were reported by teachers as critical obstacles to planning field trips. Viveiro and Diniz (2009) also noted that funding and lack of time together with school directive board lack of support and students (mis)behaviour and the additional responsibility that taking students for a field trip imposes on teachers are the main factors that interfere with field trips planning and reduce its frequency. Zamalloa, Maguregi, Fernández, Echevarría and Sanz (2014) found that teachers do not do field trips because they do not have time, field trips cost money, and classes have too many students. Han and Foskett (2007) encountered concerns not only about the size of the class, and safety issues, but also about the impact on other classes of taking teachers and pupils out of schools. To these authors, these constraints require considerable political work by teachers in schools to overcome them, otherwise they will offer insuperable barriers to the development of fieldwork.

OBJECTIVES

In Portugal, geology is taught in low secondary school (7th to 9th grade) as well as in secondary school (10 and 11st grade), together with biology, and also in the 12th grade, as an independent course. Besides, although a

teacher is qualified to teach geology in both school levels, schools tend to allocate teachers to a certain school level, based on the school needs and on the teachers' preferences. Also, field activities may be carried out in order to attain diverse aims, being some of them focused mainly on cognitive aspects and others on the affective ones. This means that, although teachers have the same previous background, they may use field activities with different purposes in the diverse school levels they are asked to teach.

Thus, the main goal of this research is to compare how biology and geology teachers use geology field activities in low secondary school and in secondary school science courses. The objectives of the research are to investigate: whether and why do teachers teaching geology in these two school levels use (or do not use) field activities; when are field activities performed with regard to concept teaching, in the two school levels; how satisfied teachers feel with the field activities that are carried out in the school level they are used to teach; what would be the ideal time relationship between concept teaching and field activities performance; what activities are carried out before, during and after a field trip, in the two school levels.

This research adds to the state of the art as no empirical research focusing on a comparison of the use of field activities in different school levels in known.

THE STUDY

Data were collected by means of a questionnaire developed for the purpose of this study. Taking as reference the objectives of the study, the questionnaire starts by asking teachers to provide a few personal and professional data to be used for sample characterization purposes and also to make sure that they qualify to belong to one of the groups that are under question in this paper. Afterwards, it focuses on issues like: frequency of use of field activities; reasons to use/not use field activities; relationship between time of concept teaching and field activities performance; level of satisfaction with field activities performed; activities carried out before, during and after the field trip.

The questionnaire was designed using Google Docs, it was content validated with two science education specialists and two secondary school teachers, and it was ameliorated after their suggestions. Then it was submitted to the ministry of education in order to get permission to send it to schools. As soon as this permission was obtained, data collection procedures were set up.

Thus, 303 school networks, spread all over the country, were selected and invited to participate in the study. Each selected school network Director was asked to collaborate and to choose four teachers, two of them teaching geology in low secondary school and two teaching geology in secondary school (as defined above), among his/her school network teachers with a minimum of three years of teaching experience. Afterwards, the Director would invite them to participate in the study and ask them to reply to the questionnaire which was available on-line, through a web-link given to them. Following (McMillan & Schumacher, 2010), answering to the questionnaire was assumed to be an acceptable way of showing informed consent to participate in the study. Data were got from a total of 233 Portuguese geology teachers, 102 teaching at the low secondary (LS) school level and 131 teaching at the secondary (S) school level.

Table 1 shows that both groups of participant teachers are quite similar with regard to gender, with more females as usual, but they differ with regard to age and previous teaching experience. However, as it should be expected, low secondary school teachers are younger than their secondary school counterparts. This difference is due to the fact that usually more experienced teachers are appointed by the school leaders to teach at the secondary school level, as this one is expected to be more demanding.

Table 1: Characteristics of the sample (%)

(N=233)

Variable	Categories	Low secondary school teachers (n=102)	Secondary school teachers (n=131)
Gender	Female	81	78
	Male	19	22
Age	30 to 40 years	30	8
	31 to 50 years	53	53
	Over 50 years	17	39
Teaching experience	5 to 10 years	5	1
	11 to 20 years	61	26
	21 to 30 years	25	53
	Over 30 years	9	20
Higher academic degree	First degree	65	57
	Post-graduation	12	12
	Research master	22	30
	PhD	1	1

Whatever the group, the majority of the teachers are first degree holders only. The secondary school group includes more master holders than the low secondary school group. For what is known about the Portuguese biology and geology teachers' population, these characteristics of the sample suggest that it compares to teachers teaching geology in schools at the two school levels under question.
In the case of close questions, data analysis comprises computation of absolute and relative frequencies per category of answer, assuming each *a priori* possible answer as a category of answer. As far as open questions are concerned, content analysis was done, sets of *a posteriori* categories of answers were developed, and computation of absolute and relative frequencies per category of answer was performed.

FINDINGS

Teachers' use of field activities

Data given in table 2 show that the percentage of teachers that state that they use field activities in their classes is larger in the secondary school group (76%) than it is in the low secondary school one (48%). Most of the teachers that stated that they use field activities mentioned that they promote one to three a year. Only in the secondary school group a few teachers (8%) mentioned that they use this type of activities more than three times a year. These results are consistent with those obtained by Han and Foskett (2007), with geography teachers, Dourado (2001), with natural sciences teachers, and Rebelo and Marques (2000), with geology teachers.

Table 2: Teachers' use of field activities (%)

(N=233)

Use of field activities		School level	
		Low Secondary (n=102)	Secondary (n=131)
Do not use		52	24
Use	1 to 3 times a year	48	68
	more than 3 times a year	0	8

Teachers that do not use field activities justified this fact based on three main groups of ideas. One of them is related to field trip management. According to these teachers: field activities require students' engagement which is hard to achieve with classes that include a large number of students; the syllabuses are very long and teachers have not enough time to perform field activities; to do field activities they would need to organize a field trip which has some costs that the school cannot afford to pay. As a teacher stated, "Field visits that require transportation are very hard to organize when school has no money for that and students' families cannot pay for it" (LS59). These results are consistent with those obtained by other authors that found that teachers mention difficulties related to: the length of the syllabuses (Michie, 1998; Anderson, Kisiel & Storksdieck, 2006); the cost of the field trip (Anderson, Kisiel & Storksdieck, 2006; Viveiro & Diniz, 2009; Michie, 1998; Zamalloa, Maguregi, Fernández, Echevarría & Sanz, 2014); the large number of students per class (Zamalloa, Maguregi, Fernández, Echevarría & Sanz, 2014).
The second one is related to students themselves. According to teachers: some students are busy after school and therefore they would not be able to go for a field trip; students are not interested in science and therefore it is not worth organizing such kind of activities; some students are immature and they conceptualise field trips as being leisure moments and misbehave during the field activities. As a teacher wrote: "Students do not always behave properly; this is especially true for the younger ones." (LS59). Viveiro and Diniz (2009) also report difficulties related to students misbehaviour.
The third one has to do with teachers themselves. According to these teachers: they do not feel motivated enough to organize field trips which are activities that require a lot of preparation; they do not know enough about the geology of the school environment so that they can organize a useful field trip. In fact, a teacher stated "I feel unsecure when thinking about going out with students for a field visit as I am aware that I have not enough training to do it" (S91), and another one stated "I am not familiar with the geological pathways of the area where I have been teaching" (LS95). Research results show that teachers seldom mention difficulties related to their knowledge and/or characteristics to justify the non-performance of field activities. However, these results are consistent with those obtained by Dourado (2001), as he found that about one third of the teachers that participated in the study he undertook stated that they were not used to carry out field activities as they did not know the place that should be the venue of the field trip.
Teachers that stated that they use field activities, gave reasons for it that depend on when they introduce the field activity in the teaching sequence. Those that use the field activity before the teaching of the related concept tend to justify it based on the idea of motivating students ("Usually to motivate students integrated in a problem based learning approach" (S117)). Those that use field activities during concept introduction they tend to state that they

integrate both and do it in order to foster students' conceptual learning ("[If field activities are performed] During the teaching of the new concepts students may more easily integrate them some previous learning." (S131)) . Finally, those that use field activities after teaching the related concepts mention that they do it in order to reinforce previously acquired knowledge ("I believe that it will be more easy for the students to understand geological processes or identify rocks [in the field] if they have study the concepts in advance" (LS94)).

Concept teaching and field activities performance

Teachers that stated that they use field activities seem to introduce them at different stages with regard to the related concept teaching (table 3). Some of them stated that they use them at a single stage, but others mentioned that they use them at two or three different stages. However, on one hand, there is a slight tendency for performance of field activities after concept teaching to prevail, whatever the teachers' group, even though these percentages are lower than those obtained by Scortegagna (2005), also with geology teachers. Those teachers believe that "Concept mastery is a previous condition for field activities to succeed." (LS43). On the other hand, only about one third of each group stated that they use field activities at the three different stages of the teaching sequence: before, during and after concept teaching. This finding is consistent with the existence of different types of field activities that have different performance requirements so that they can lead to different learning achievements. Thus, it may mean that these teachers may have clear ideas on how to use field activities so that students can take most profit from them. One of the teachers mentioned that:

> "When they are carried out before [teaching], they aim at raising students' curiosity an motivating them to study a given topic; if they are carried out during [teaching] then they offer a complement to learning that has just been done and give room for new learning to take place; when they are performed after teaching the concepts, then they reinforce learning that has already been done." (S110).

Table 3: Time relationship between field activities performance and concept teaching (%)

(N=149)

Field activities *versus* concept teaching	School level	
	Low Secondary (n=49)	Secondary (n=100)
Before	8	1
During	18	20
After	31	32
Before or during or after	23	21
Before or during	0	3
Before or after	10	7
During or after	10	16

The whole sample was asked about the ideal time for using field activities with regard to concept teaching if it was only up to the teachers to choose when to use them. As far as teachers that stated that they are used to use field activities are concerned, the percentage of teachers that would like to use this type of activities during concept teaching (table 4) almost doubled, in both school levels, when compared with the percentage given in table 3. This means that there are more field activities users' that value the use of field activities during concept teaching than those that use them in such way. This difference was not observed by Morcillo, Rodrigo, Centeno and Compiani (1998) that obtained similar percentages for the two cases. In addition, and opposite to what Morcillo, Rodrigo, Centeno and Compiani (1998) have concluded, the latter field activities users seem to practice field activities after teaching (table 3) more than they would like to (Table 4).

Table 4: Ideal time relationship between field activities performance and concept teaching (%)

(N=233)

Field activities versus concept teaching	Field activities users		Field activities non-users	
	Low Secondary (n=49)	Secondary (n=100)	Low Secondary (n=53)	Secondary (n=31)
Before	8	6	8	13
During	35	36	24	32
After	19	15	38	29
Before or during or after	16	26	13	13
Before or during	8	5	2	3
Before or after	6	5	9	3
During or after	8	7	6	7

Besides, the percentages of field activities non users that would like to use field activities during concept teaching are a bit smaller than those obtained for field activities users. In addition, the percentages of field activities non-users that stated that they would use field activities after teaching the concepts are almost the double of those obtained for the field activities users. These results suggest that in the non-user group there are larger percentages of teachers acknowledging inductive ideas than in the user group.
The percentages of teachers that mentioned that they use (users) or would like to use (non-users) field activities before teaching are very limited. As far as the users group is concerned, this result is surprising because it inconsistent with results obtained by Morcillo, Rodrigo, Centeno and Compiani (1998). In fact, these authors found that the percentage of teachers that practice field activities before teaching is higher than that of teacher that would like to use field activities at that same stage.

Field activities users' level of satisfaction
Most of the teachers feel satisfied or completely satisfied with the field activities that they have been performing, whatever the school level (table 5).

Table 5: Field activities users' level of satisfaction with field activities performance (%)
(N=149)

Level of Satisfaction	School level	
	Low Secondary (n=49)	Secondary (n=100)
Completely satisfied	33	35
Satisfied	43	46
Moderately satisfied	24	18
Fairly satisfied	0	1
Unsatisfied	0	0

This would be a good result if teachers had reported that they use field activities often and if they were using them appropriately. As findings reported above suggest that this may not be the case, this high level of satisfaction among both groups of teachers is a cause for some concern because if teachers feel satisfied with their inadequate practices, they are not to be expected to feel the need to change them and consequently they would not be expected to look for either advice or training on how to improve their practices with regard to field activities use.

Field trip associated pedagogic activities
Several pedagogic activities may be carried out before, during and after a field trip. Field activities users were asked about whether or not they promote pedagogic activities in each one of these steps. All of them stated that they do it. However, some of the activities they put forwards are teacher centred and seem to be related to teacher class preparation activities rather than activities targeted to students (table 6). This is the case of activities design and/or planning that is the item mentioned by the largest percentage of teachers. Other activities are formulated from a teacher's point of view, as it is the case of concept teaching and problem presentation (which are tasks that the teacher is supposed to do). There is also an activity (Definition of assessment criteria) that was classified as teacher centred because it is usual to have teachers deciding on assessment criteria even though this sort of decisions should involve students too. However, it is not completely clear that it is a student's centred activity, as it may be illustrated by the following answer: "Elaboration of the evaluation process" (S126). As a matter of fact, this answer does not clearly show who is involved in the elaboration mentioned.

Table 6: Activities carried out before the field trip (%)
(N=149)

Responsible person	Activities	Low Secondary (n=49)	Secondary (n=100)
Teacher	Activities design and/or planning	14	50
	Problem presentation	6	1
	Concept teaching	18	15
	Definition of assessment criteria	6	7
Students participation	Knowledge about the place to visit including to its geology	27	21
	Definition of methodologies to be followed in the field	49	38
	Definition of safety rules	6	6

	Training of relevant skills	2	8

Some other activities are formulated by teachers in such a way that one can infer that students are involved into them. Those mentioned by the largest percentages of teachers focus on methodologies to be followed in the field and on knowing the place to visit, including its geology. In fact, one of the teachers mentioned that he/she does activities aiming to "select and convey to students the goals of the activity; to prepare the field visit worksheet, together with students" (LS41) and another one mentioned that he/she wants "to make students familiar with the geology of the place to be visited." (S28). Participants in the study carried out by Zamalloa, Maguregi, Fernández, Echevarría and Sanz (2014) also reported that they prepare the field trip either by giving a sort of lecture on the theme or by showing a video, probably to make students familiar with the place to visit.

As far as activities carried out in the field are concerned, table 7 shows that teachers selected activities centred in the students as well as activities centred in themselves. With regard to the former, figures suggest that the percentages of teachers that selected the diverse levels of frequency of performance of each type of activity that can be carried out in the field are quite similar for the two school levels. However, the majority of teachers, of both groups, stated that students are asked to "Collect samples" and "Do measurements" in a few activities only. In addition, low secondary school teachers seem to ask students to Identify Problems in fewer activities than their counterparts do. In fact, 55% of the low secondary school teachers *versus* 44% of the secondary school teachers stated that they ask students to do it in none or in few activities. This may mean that teachers either conceptualise this task as less appropriate for younger than for older students or may feel that younger students are unable to perform it. As teachers stated: "I have been teaching in low secondary school: it is fully necessary to guide students in the activities they are asked to do" (LS76); "Students need to be guided and there are some contents that must be explained in the field because they are not able to discover them." (S48).

With regard to teacher centred activities, low secondary school teachers seem to give guidance, to explain and to ask question to students within the scope of fewer activities than their secondary school counterparts do. On the opposite, and as it should be expected, secondary school teachers tend to observe students in more activities than their low secondary school counterparts do. This may mean that secondary schools teachers have their students working in the field more autonomously than their low secondary school counterparts do. Besides, it may mean that there are several different causes for it, including the way they see students. As a teacher stated: "Depending on students' autonomy, I may allow them to carry out the activities on their own or not. However, I think that it is important to observe them and to ask questions to them in order to promote learning." (S74).

Table 7: Activities carried out in the field (%)

(N=149)

Responsible person	Activities	Proportion of field activities							
		None		A few		Most		All	
		LS	S	LS	S	LS	S	LS	S
Students	Carry out observations	0	0	0	6	22	12	78	82
	Identify Problems	0	1	55	43	45	41	0	15
	Collect samples	2	7	59	55	31	31	8	7
	Do measurements	2	7	59	65	31	24	8	4
	Make drawings/schemes	0	3	33	38	51	37	16	22
	Make photographs	0	1	0	10	33	25	67	64
Teachers	Guide students	0	1	0	17	31	27	69	55
	Explain to students	0	2	12	22	23	21	65	55
	Ask questions to students	0	1	6	16	20	21	74	62
	Observe students	0	1	2	4	22	10	76	85

Note: LS = Low Secondary school (49 teachers); S = Secondary school (100 teachers)

There are a few differences between the two groups of teachers, with regard to the activities performed after the field trip (table 8).

Table 8: Activities carried out after the field trip (%)

(N=149)

Responsible person	Activities	Proportion of field activities							
		None		A few		Most		All	
		LS	S	LS	S	LS	S	LS	S
Student	Report preparation	18	1	2	26	41	28	39	45
	Discussion on the activities	0	0	0	4	84	16	16	80
	Planning of new activities	49	38	33	51	4	8	14	3
	Problem-solving	47	4	4	53	16	31	33	12

Teacher	Teach new knowledge on activity	37	15	16	49	18	21	29	15
	Reinforce knowledge on the activities	14	1	2	17	57	30	27	52

Note: LS = Low Secondary school (49 teachers); S = Secondary school (100 teachers)

In fact, the percentages of low secondary school teachers that do not ask students to write a report, to do problem-solving and to plan new follow-up activities for the activities performed are higher than the corresponding secondary school ones. Anyway, teachers in both groups seem to believe that students are not skilled enough to plan activities, as they state: "Designing new activities is not always an easy task for this grade level (7th grade)" (LS80); "Planning is teachers' responsibility" (S62). Teachers believe that reports are useful tools for learning and assessment. Therefore, they put forwards justifications including ideas like these: "Writing a report […] is useful to consolidate learning carried out during a field trip" (LS26) and "As far as reports are appropriately supervised, so that plagiarism is prevented, they are very important for the teacher to assess student' understanding of the field activity." (S9).

Besides, discussion of the activities carried out in the field seems to be the most popular student centred post field trip activity among both groups of teachers. Also, the majority of both groups seem to use knowledge reinforcement activities very often, that is in association with most or all field activities performed. To justify that, they argue that post field trip activities are useful "To remember, to consolidate, and to bridge theory and practice and to gain some feedback on the activities performed" (LS5) and "To consolidate acquired knowledge or competences" (S20). Finally, secondary school teachers seem to teach field activity related knowledge a bit more rarely than low secondary school counterparts do.

CONCLUSIONS AND IMPLICATIONS

It is commonly accepted that field activities may have high educational value. However, their real learning outcomes depend on the way they are structured and implemented. The results of this study show that, opposite to what happens in the secondary school, the majority of low secondary school teachers do not use field activities. Besides, the majority of field activities users promote less than four activities per year. In addition, most of them do not seem to have an appropriate understanding of how field activities should be used to become a valuable educational resource. This statement is based on the fact that the reasons they put forwards to justify the relationship between concept teaching and activity performance are not underlined by arguments showing neither an awareness of the diversity of types of field activities nor the necessary match between the learning objective to be attained and the structure of the activity to be performed. Besides, teachers do not trust too much students' ability to play an active role as learners, as they argue for teacher centred activities based either on the idea that students are not able to carry out the activity or on the belief that undertaking it is teachers' responsibility. Bearing in mind these results, the fact that the majority of teachers feel satisfied or even completely satisfied with the way they have been dealing with field activities is a striking issue. This suggests that teachers are not conscious about the inconsistencies of their practices with the state of the art regarding the use of field activities in science teaching. A consequence of this is that geology teachers' practices need to be improved. However, changing teachers' conceptions on the issue of using field activities for teaching geology seems to be a necessary condition for teachers' practices to become more consistent with research results on the topic. As a matter of fact, as teachers seem to value teacher centred approaches, students' engagement with field activities (that would lead them to develop in an integrated way practical, theoretical and reasoning competencies) is at risk. This means that in-service courses on the issue of this paper should be organized but they cannot focus on field activities related issues only. Rather, they should start with a discussion on the cognitive and affective aspects of the learning process so that teachers change the way they look at students' cognitive abilities and learn how to trust their learning competencies. Empirical information from student centred or active methods should be used to provide evidence of what students are able to do when they have the opportunity to play a central role in the learning process. Afterwards, an epistemological discussion to help teachers to overcome some myths about science (McComas, 2002) and to make it clear that there is a complex interplay between theory and practice (Leach, 1999) should be held. This would be important to argue against a single type of field activities as well as against a single way of relating theory and field activities. Finally, and based on this and other research results, it seems necessary to make teachers become aware not only of the types of tasks that can be performed before and after the field activities (Lopez, 2008; Rebelo, Marques & Costa, 2011) but also of the way they may fit with different the types of field activities (Dourado & Leite, 2013). The pre field tasks should prepare students for the field activity but they cannot provide information that negatively interferes with the desired students' engagement with the field activity (which, of course, depends on the type of activity). With regard to post field (follow-up) tasks, those that seem to be more neglected by teachers (Remmen & Frøyland, 2015) and researchers, it seems necessary to find out ways of making them to become an added value for students. This may require working from both tasks and learning that took place in the field and going a step further in a direction that may depend on what was done in the field as well as on the content and the school level that are at stake. In any case, decisions on hands-on, minds-on and hearts-on need to be balanced against

the learning targets so that carrying out field activities can become an added value to science education in general and Geology education in particular.

References

Albergaria-Almeida, P., Barros, J., & Cruz, N. (2013). Conceções e práticas de professores de geologia sobre trabalho de campo. *Enseñanza de las Ciencias*, *nº extra*, 47-53. Available at: http://congres.manners.es/ congres_ciencia/ gestio/creacioCD/cd/articulos/art_850.pdf

Alvarez-Suárez, R. (2003). La utilización de modelos experimentales en geologia. *Alambique: Didáctica de las Ciencias Experimentales, 35*, 60-69.

Anderson, D., Kisiel, J., & Storksdieck, K. (2006). Understanding teachers' perspectives on field trips: discovering common ground in three countries. *Curator: The Museum Journal, 49* (3), 365-386.

Compiani, M., & Carneiro, C. (1993). Os papéis didácticos das excursões geológicas. *Enseñanza de las Ciencias de la Tierra*, *1* (2), 90-98.

DeBoer, G. (2000). Scientic literacy: another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, 37 (6), 582-601.

Del Carmen, L. (1999) El estudio de los ecosistemas. *Alambique: Didáctica de las Ciencias Experimentales*, *20*, 47-54.

Dillon, M. (2011). Teaching science outside the classroom. In R. Toplis (Ed) *How science works* (p.134-147). London: Routledge.

Dourado, L. (2001). *O trabalho prático no ensino das ciências naturais: situação actual e implementação de propostas inovadoras para o trabalho laboratorial e o trabalho de campo*. (Unpublished doctoral thesis), University of Minho, Braga, Portugal.

Dourado, L., & Leite, L. (2013). Field activities, science education and problem-solving. *Procedia - Social and Behavioral Sciences, 106*, 1232 – 1241. Available at www.sciencedirect.com.

García, E. (1994). Metodología y secuenciación de las actividades didácticas de geología de campo. *Enseñanza de las Ciencias de la Tierra*, *2* (2), 340-353.

Han, L., & Foskett, N. (2007). Objectives and constraints in geographical fieldwork: teachers' attitudes and perspectives in senior high schools in Taiwan. *International Research in Geographical and Environmental Education, 16* (1), 5-20.

Kisiel, J. (2005). Understanding elementary teacher motivations for science fieldtrips. *Science Education, 89* (6), 936-955.

Leach, J. (1999). Students' understanding of the co-ordination of theory and evidence in science. *International Journal of Science Education*, *21* (8), 789-806.

Liu, X. (2010). Beyond science literacy: science and the public. *International Journal of Environmental & Science Education*, *4* (3), 301-311.

López, J. (2008). Las salidas de campo: mucho más que una excursión. *Educar en el 2000*, *11*, 100-103.

McMillan, J., & Schumacher, S. (2010). *Research in education: a conceptual introduction*. 5th Ed. Boston: Pearson.

Michie, M. (1998). Factors influencing secondary science teachers to organise and conduct field trips. *Australian Science Teacher's Journal, 44* (4), 43-50.

Morcillo*, J., Rodrigo, M., Centeno, J., & Compiani, M. (1998)*. Caracterización de las prácticas de campo: justificación y primeros resultados de una encuesta al profesorado. *Enseñanza de las Ciencias de la Tierra, 6* (3), 242-250.

Pedrinaci, E., Sequeiros, E., & García, E. (1994). El trabajo de campo y el aprendizaje de la geología. *Alambique: Didácticas de las Ciências Experimentales*, *16* (1), 17-20.

Rebelo, D., & Marques, L. (2000). *O trabalho de campo em geociências na formação dos professores: situação exemplificativa para o Cabo Mondego*. Aveiro: University of Aveiro.

Rebelo, D., Marques, L., & Costa, N. (2011). Actividades en ambientes exteriores al aula en la educación en ciencias: contribuciones para su operatividad. *Enseñanza de las Ciencias de la Tierra, 19* (1), 15-25.

Remmen, K., & Frøyland, M. (2015). What happens in classrooms after earth science fieldwork? Supporting student learning processes during follow-up activities. *International Research in Geographical and Environmental Education, 24* (1), 24-42.

Scortegagna, A. (2005). Trabalhos de campo nas disciplinas de geologia introdutória: cursos de geografia no estado do Paraná. *RA'EGA, O Espaço Geográfico em Análise, 9*, 37-46.

Scott, I., Fuller, I., & Gaskin, S. (2006). Life without fieldwork: some lecturers' perceptions of geography and environmental science fieldwork. *Journal of Geography in Higher Education, 30* (1), 161–171.
Stokes, A., Magnier, K., & Weaver, R. (2011). What is the use of fieldwork? Conceptions of students and staff in geography and geology. *Journal of Geography in Higher Education, 35* (1), 121-141.
Thomas, G. (2012). Metacognition in science education: past, present and future considerations. In B. Fraser, K. Tobin, & C. McRobbie (Eds) *Second International Handbook of Science Education* (p. 131-144). Dordrecht: Springer.
Toro, R., & Morcillo, J. (2011). Las actividades de campo en educación secundaria. Un estudio comparativo entre Dinamarca y España. *Enseñanza de las Ciencias de la Tierra*, *19* (1), 39-47.
Veenman, M. (2012). Metacognition in science education: definitions, constituents, and their intricate relation with cognition. In A. Zohar, & Y. Dori (Eds) *Metacognition in Science Education* (p. 21-36). Dordrecht: Springer.
Viveiro, A., & Diniz, R. (2009). As atividades de campo no ensino de ciências. In R. Nardi (Org) *Ensino de ciências e matemática, I: temas sobre a formação de professores* (p. 27-42). São Paulo: Cultura Acadêmica.
Zamalloa, T., Maguregi, G., Fernández, M., Echevarría, I., & Sanz, J. (2014). Acercar la geodiversidad através de las salidas de campo en la ESO. Una investigación con el profesorado de ciencias de Bizkaia. *Enseñanza de las Ciencias, 32* (3), 443-467.