Lab Work and Field Work in the Study of Ecosystems – an investigative approach

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SUMMARY. Practical work (including laboratory work and field work) has an important role to play in science education. Some authors even argue that science education would be incomplete if it does not include some laboratory work. Teacher education has focused on the theoretical aspects of using practical work and has neglected the practical part of it. Thus, the objective of this paper is to present some results obtained with a workshop for Natural Sciences teachers, which emphasises the practical component and that aims to lead teachers to use practical work in their science classes. The workshop started with the characterisation of Biology and Natural sciences teachers' views and expectations about the results of the practical work carried out in schools and the identification of the aspects they feel should be modified in their own practice. Then, teachers were asked to suggest and develop practical activities taking as reference the following topic: "Study of a specific aquatic ecosystem: the pond". Those activities include laboratory activities and field activities. They were intended to enable the collection of data on biotic and abiotic factors, the identification and classification of animals and plants, the establishment of some inter-relationships among the elements of this biocenosis as well as the characterisation of the way the abiotic factors exert influence on it. Finally, the teachers participating in the course were asked to apply the knowledge acquired through the field-work undertaken during the course to the development of activities to be implemented in the laboratory. The evaluation of the course indicates that at first teachers felt uncomfortable with the kind of work suggested to them but that soon they started to overcame those difficulties and some of them even succeeded in applying the knowledge acquired to their own classes.

KEY-WORDS: practical work, laboratory work, field work, investigative approach.

RÉSUMÉ. Le travail pratique (y compris le travail de laboratoire e le travail sur le terrain) a un rôle très important dans l'éducation en Science. Quelques auteurs disputent que cette éducation en science serait incomplète s'elle n'inclut pas quelque travail de laboratoire. L'utilisation du travail pratique dans l' enseignement des sciences a convergé sur les aspects théoriques d'utilisation et a négligé la partie pratique de cela. Ainsi, notre objectif sera présenter quelques résultats, obtenus avec un atelier, pour enseignants de Sciences Naturels, lesquels donneraient plus importance à un composant pratique et cela viserait son usage dans leurs classes de sciences. L'atelier a commencé avec la caractérisation des points de vue et expectatifs des enseignants de Biologie e Sciences Naturels, sur les résultats du travail pratique qu'ils exécutent dans leurs écoles et l'identification des aspects qu'ils sentent, devraient être modifiés dans leur propre pratique. Aux enseignants, a été suggéré le développement d' activités pratiques, qui ont pris comme référence le sujet suivant: L' étude d'un aquatic ecosystem spécifique: l'étang". Ces activités incluent les activités de laboratoire et le travail sur le terrain. Ils devraient obtenir des donnés sur les facteurs biotics et abiotics, l'identification e classification d'animaux et des plantes, l'établissement de quelques inter-rapports entre les éléments de ce biocenosis, de même que la caractérisation de la façon comme les facteures abiotics exercent son influence. Finalement, les enseignants ont été demandés d'appliquer la connaissance acquise dans le travail entrepris sur le terrain et développer cette connaissance avec des activités dans le laboratoire. L'évaluation du cours, indique le suivant: au début, les enseignants étaient inconfortables avec le genre de travail qu'on l'a suggéré mais, bientôt, ils ont commencé à réussir ces difficultés et ils ont réussit même l'application de la connaissance acquise dans leurs propres classes.

MOTS-CLES: travail pratique, travail de laboratoire , travail sur le terrain, perspective investigative.

Introduction

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Practical work, seen in a broader sense as lab and field work, is an essential element of science teaching. On what concerns Natural Science, particularly when addressing Ecology themes, its role is even more relevant.

The concept of an ecosystem is a basic concept for the comprehension of nature as it "helps to establish a complex, dynamic and interactive insight of the latter"[3]. When theorectical approaches to this concept are limited to a listing of the characteristics of the different living beings that define it, neglecting the context in which they live, a fundamental dimension, which relates to the interaction among different organisms and between these and their natural environment, is being forgotten.

We believe that this situation can be overcome by means of practical field and lab work. These should reveal investigative characteristics and should be developed in an articulated way in order to contribute decisively to surmount some less clear conceptions, as for instance the static and less interactive idea we have of the living beings.

The development of practical work with investigative characteristics involves the total or partial definition of the problem and/or of the variables under investigation, the design and selection of suitable observation/investigation procedures, data collection and analysis and finally, the drawing of conclusions.

In an investigative activity it is necessary to consider three types of concepts: "those which are necessary to know and comprehend in order to be able to undertake the activity", "the concepts necessary to the realization of the task" and "the concepts which are developed during the investigation itself" [4] .

As said before, the field and lab work should be developed in an articulate way, which means that they should not be considered totally independent but, despite some level of specificity and autonomy, they should complement each other. The virtualities of each type of work can be amplified and complemented, contributing to more coherent global results. This approach is even more relevant when considering thematics with further levels of complexity, as in the case of the aforementioned study of the ecosystem.

Field activities (as suggested for instance in the curricular project "Investigacion y Renovacion escolar (IRES) "of the Grupo de Investigacion en la Escuela – Sevilla), should address a specific and relevant practical problem, the participants should be organized in groups and the work should be developed in activity blocks.

Initial activities should allow the participants to acnowledge their own prior considerations, provide informations on the issues and the work system which will be undergone, allow the definition of basic problems and bring forth some answers/proposals that may encourage and orient subsequent work.. The role of the teacher is to guide the discussion, to clearify unclear aspects, to provide opportunities for the first conceptual confrontation based upon conflictuous suggestions of the participants.

The lab work is an area which concerns the development of both specific activities and those which are received through field work. In the lab/classroom, activities which enable to simulate, reproduce and/or deepen aspects observed outdoors may be developed. Furthermore, lab acrivities may even suggest new field activities.

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[3] Del Carmen, L., "El estudio de los ecosistemas", *Alambique : Didáctica de las ciencias experimentales – El trabajo científico en el aula/El estudio de la ecologia*, 20, 1999, 47-54

[4] Watson, J. R. "Diseno y realizacion de investigaciones en las clases de ciencias", *Alambique: Didáctica de las ciencias experimentales – Los trabajos prácticos*, 2, 1994, 57-65.

Proposal of articulation between field and lab work

The model in figure 1, suggested by Dourado and Freitas [5], illustrates the way in which we conceive the interaction Field/Lab argued before.

During field work, materials will be collected and all information on what is being observed, including new questions and possible solutions, will be retained. Both will then be analised in a broader context in which it is possible to continue, complement and/or redefine field observations. Thus, it shall be suggested to students that they devise a work project to be undertaken in the lab.

Following the lab simulation, all observational activities will be systematically recorded. The results obtained will be confronted with the field observations and they may even suggest further field activities. In addition to this, it is possible to address issues which initially could not be addressed during the field work.

Finally, generalising complementary activities will be developed with a view to the deepening of some aspects of the work which will be summed up in a final and individual record.

The methodology of the activities undertaken

The following example reveals the way in which we view the development of the lab/field activities. It relates to a project developed with a group of high school teachers of Natural Sciences during a 14 work session workshop.

Our proposal consisted in the study of a specific ecossystem – a pond, we had previously selected. The diversity of life forms provided by the earth environment is an unquestionable and easily observable reality. On the other hand, the life forms existing in the salted or sweet waters of a pond are frequently somewhat neglected. Existing living beings (algae, plancton…), as in every other earth environment, interact among themselves and even contribute to the evolution and changing of their habitats. Therefore, the pond is an excellent example of an ecossystem to be considered in our study.

The following work proposal was suggested to the group of teachers we were working with: "The study of an ecossystem (pond) through the planning and development of a group of field and lab activities allowing: the collecting of data addressing biotic and abiotic factors, classifying and identifying the animals and plants which constitute the biocenosis of their ecosystem, trying to establish interactions among the members of this biocenosis as well as the characterization of the way in which the latter is influenced by abiotic factors.

The field work should include activities which allowed the best characterization possible of the pond. Necessary observations should be recorded and relevant samples collected. The lab activities should complement field activities (namely on what concerns prior trials and complementary observations). A small pond should even be created in the lab, as similar as possible to the real one. The work should be followed through this simulator, enabling the collection of data complementing the field research and also the experiencing of trials which would lead to the drawing of some conclusions concerning what might have happened in the natural environment".

Prior to the field work, several crutial lab parameters measurements took place (pH, nitrates, dissolved oxygen, etc), which were considered fundamental for the undertaking of the field activities.

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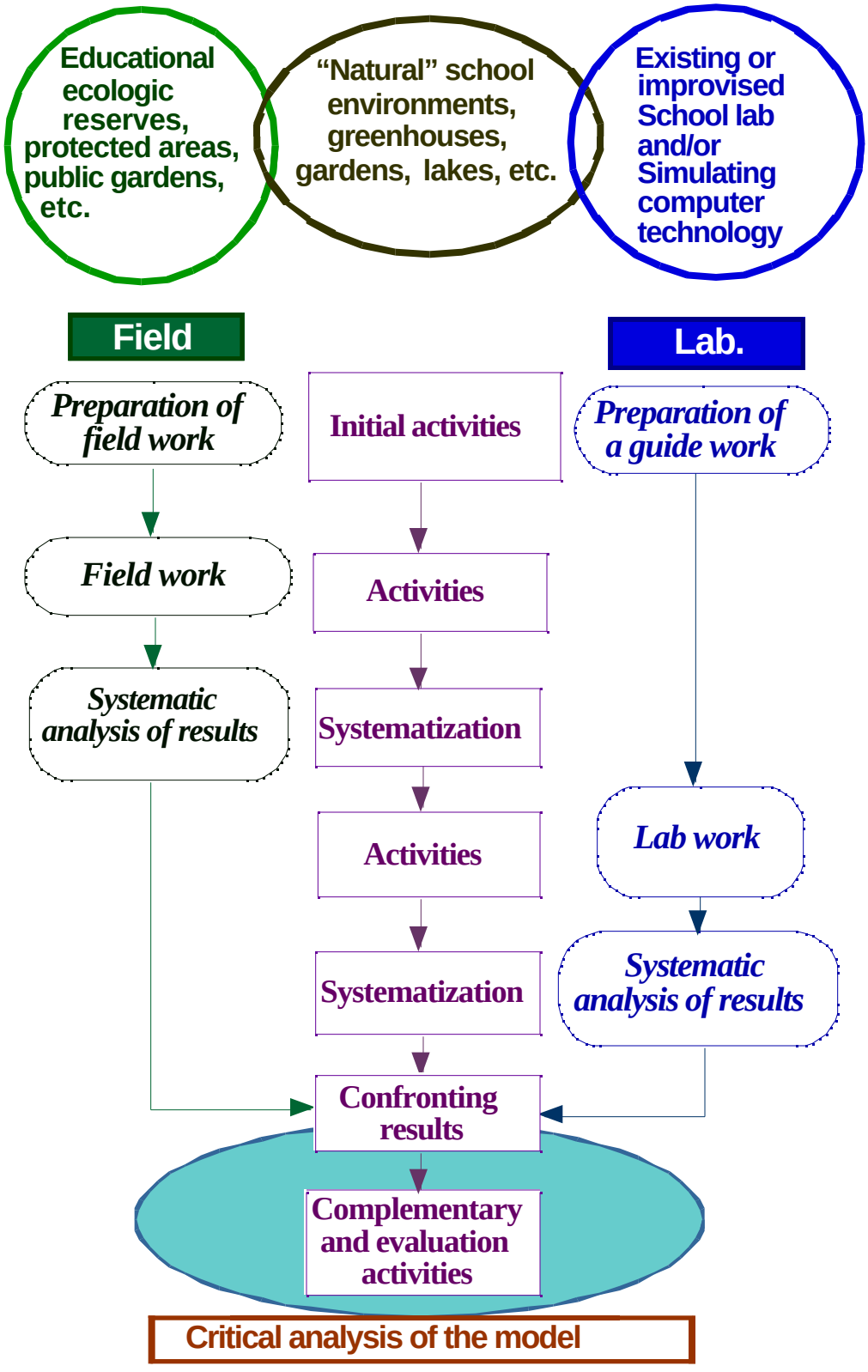
[5] Dourado L. & Freitas M., "Actividades a Desenvolver em Reservas Ecológicas Educativas", *Cadernos de Educação Ambiental*, 14, 1998.

For the field work,, each group, with full autonomy, developed the tasks devised: to locate the area on a topographic chart, to draw a sketch of the place indicating the biggest amount of data (houses, paths, orientation, nearby vegetation areas…), the identification of animal and vegetable species, physical and chemical parameters' measurements and sample collections. The different participants recorded relevant information on a field notebook we had provided.

Back in the lab and according to the plan, the materials collected were placed in the aquarium (water, mud, some plants) as well as a big waterlily.


Educational ecologic reserves, protected areas, public gardens, etc.
"Natural" school environments, greenhouses, gardens, lakes, etc.
Existing or improvised School lab and/or Simulating computer technology
Field
Lab.
Preparation of field work
Initial activities
Preparation of a guide work
Field work
Activities
Systematic analysis of results
Systematization
Activities
Lab work
Systematization
Systematic analysis of results
Confronting results
Complementary and evaluation activities
Critical analysis of the model

From the discussion resulting from the field work, we concluded on the lack of consistency and validity of some measurements (both few and in small locations) as well as on the difficulties in characterizing systematically all observations held. Some vegetable species were identified in an isolated way and most of them were hard to identify at all. We decided on a second field trip and consequently the guide plan was redesigned and new supporting materials were requested by the teachers, namely field guides to identify animal and vegetable species,as well as film and photographic cameras.

During the second field trip we concluded that the understanding of the great diversity of living species that constitute the ecossystem can only be accomplished when its reality is studied *in situ.* As exact as a theorectical approach may be, it would not go beyond the listing (catalog style) of the species present in the ecosystem.

During the following working session several identification forms were filled concerning the plancton species found in the water samples collected. By this time, the teachers were reminded of one of the structural aspects of the initial work proposal which consisted in the planning of a group of activities through which the teacher is supposed to provoke, intentionally, a change in the simulator's equilibrium. This might mean for instance the changing of a physical or chemical parameter while holding the other ones constant.

The teachers, working in small groups, planned and performed three work projects: a) the effects of the variation of nitrat concentration in a population of diatomaceas, b) the effect of the pH in the development of zooplancton and c) the impact of an increase of the environment's temperature on the small fish of the pond.

At the end of every activity, we requested the elaboration of a Final Report that should include the characterization of the real pond (location, living species and possible trophic relationships between them, other elements, physical and chemical parameters); the characterization of the simulated lab pond (living species and possible trophic relationships between them, other elements and physical and chemical parameters); the resemblances of both ponds, the opportunities to exert influence on the pond deduced from the results obtained by the changes imposed on the simulated pond.

Preliminary results

At both the beginning and the end of each activity, questionnaires were held on the concept each teacher had of practical work – lab and field- and the way it should be implemented as well as on the systematization of every activity engaged in, and finally, each teacher set forth a critical global consideration on the project. Based upon the information thus obtained, it is possible to present some preliminary results :

1. When questioned on the reasons which took them to consider the pond as an example of an ecosystem, only two teachers fell short of a proper justification, other two did not mention the interactions between living beings and their environment – one of them referred to " living beings that interact and live in a specific habitat"- and one teacher considered that the established interactions are only the trophic type " some (living beings) are a feeding source for others". Additionally, when questionned on the elements they expected to find in the pond, only two teachers mentioned microorganisms. All the others only referred to macroscopic organisms.
2. When asked to propose a study methodology and the group of activities to perform with a view to the gathering of information on the pond and on the elements and materials necessary to create the lab simulated pond, some teachers were clearly uncomfortable with the task. They appeared to be expecting that we would present them with concrete tasks and a clear definition of the kind of work they would be engaged in, other than suggesting

them to bring forth work proposals themselves. One of them suggested: " I always worked with protocols in which the activities taking place , the necessary materials, the data collecting and the drawing of conclusions were clearly defined. I was confronted for the first time with the great difficult of trying to define not the activity in itself but the way in which it should be performed, which materials would be necessary, the process of collecting samples, the transportation, …".

3. The first reactions of the teachers when confronted for the first time with the field work, corresponded to the natural differences we had predicted concerning our description of the pond and reality itself. One of the participants confided:"I thought it would be bigger". As much as we may think it to be possible to describe precisely an object, it will only be so to us. Everyone observes the same reality differently.
4. After the analysis of the results of the first field work, we concluded on their inconsistency and suggested another field trip. One of the explanations suggested by one of the participants was that: " I can now understand how important it is to properly prepare a field trip. Because our group did not fix the number and timing of the temperature and conductivity measurements during our first field trip, it was impossible to draw conclusions."
5. The teachers revealed some difficulty on the performance of certain lab tasks namely the identification of zooplancton and fitoplancton. In some cases, as mentioned by a teacher, due to the lack of experience in doing it : "because it is a task that I do not perform since long", and others due to the limitations of the identification forms – most of the teachers identified a large number of microorganisms.
6. Some teachers were pleased with the results obtained through the performance of the work projects we had suggested. One of them mentioned that: "we managed to do our very own protocol on the single condition that we should make use of the materials collected during the field work just as those used in the simulator. We sought to create a protocol possible to implement with seventh graders and adequate to our schools (in terms of material availability for instance). It was an innovative research and trial activity with positive results because we managed to put into practice what the group expected."
7. Some teachers concluded that this approach can be considered during the teaching of Natural Sciences among seventh graders, namely the topical study of "The Dynamics of the Ecosystems". One of the teachers mentioned : " I can use the same approach with seventh graders on different topics and materials.".