Second International Conference on Geoscience Education

Learning about the Earth as a System

CONFERENCE

OCEEDINGS

University of Hawai'i at Hilo July 28-31, 1997

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#### Changes in the Earth-Sciences Classroom Influenced by Educational Research.

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#### Introduction

The main aim of this paper was to discuss the relationships between the suggestions provided for educational research in Earth-sciences and their reflections in school science classrooms. We claim that educational research in Science Education namely in Earth Sciences is of no value if it is not strongly reflected in practices at the classroom. Nevertheless the gap between the results achieved by the research teams and the strategies and activities still used by science school teachers is well known, i.e. the dialogue between academic researchers and practitioners has not been developed enough (Kempa 1991). We think that one of the obstacles causing this unpleasant situation is related to the lack of teachers' own participation in the activities carried out in the research teams. It seems that the picture concerned with the real situation is guite well defined: on one hand research projects are developed for science teachers rather than with teachers, and on the other hand there is a lack of inservice training programs for helping teachers rethink their practices towards innovative ones. For changing this procedure a set of attempts have been developed during the last few years in Portugal. The discussion of the context of this issue was the subject throughout this paper.

#### SHAPING THE PROBLEMS

There is a political preoccupation with, and policy emphasis on, education in general and science education in particular all over the World (Laws 1996). If there is this common view about the relevance of achieving meaningful science concepts, it is not easy to understand, at least in a first glance, why students decrease progressively their enjoyment for science as they grow. This means that one finds dissatisfaction among

- teachers about the effectiveness of their teaching.
- curriculum makers concerned with the gap between the aims pointed out and the results achieved by the students.

## Understanding of Geological Time among Children, Teachers and Student Teachers.

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The understanding of many Earth Science processes and events is strongly dependent on a grasp of geological time. This key concept lies at the very heart of geology, yet very few educational researchers have investigated how children and others conceive it. The proposition is made that UK society has no shared understanding of "deep time," unlike equivalent core concepts in other disciplines such as "life" in biology, "light years" in astronomy and "historical time" in history. There is a vicious cycle of shared ignorance and misconception, with little evidence that it can be interrupted easily. Even when geological phenomena appear in popular culture, such as Spielberg's 'Jurassic Park' film, there is no evidence that understanding of deep time is enhanced.

It is proposed that this state of collective emptiness in relation to deep time provides a barrier to understanding of other geological concepts, including events in the geological history of planet Earth. It is postulated that student teachers, teachers and parents are insecure in their grasp of deep time so they are unable to devise effective learning activities. When a child produces a fossil or asks about dinosaurs, such adults lack the knowledge and understanding needed to respond in powerful ways, which might include reference to the time context. This core concept is dismissed with phrases such as "millions of years ago" or "a long time ago" and attention is shifted, perhaps, to the specimen's physical attributes or the dinosaur's habitat.



### CHANGES IN THE EARTH-SCIENCES CLASSROOM INFLUENCED BY EDUCACIONAL RESEARCH

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#### INTRODUCTION

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#### SHAPING THE PROBLEM

There is a political preoccupation with, and policy emphases on, education in general and science education in particular all over the world (Laws, 1996). If there is this common view about the relevance of achieving meanigfully science concepts, it is not easy to understand, at least in a first glance, why students decrease progressively their enjoyment for science as they grow. This means that one finds dissatisfaction among:

- . teachers about the effectiveness of their teaching:
- . curriculum makers concerned with the gap betweeen the aims pointed out and the results achieved by the students;
- . educational researchers because the lack of potential of their findings.

The practices of the teachers in the classroom and the role palyed by the students are the starting point of the analysis of the situation we are faced. Our assumption is that the cornerstone of this issue is based on the way the teachers implement with creativity and innovation the curriculum contents rather than the designing of new curricula. In other words the practice of the curriculum i.e the curriculum in action is much more inportant than the curriculum intentional. From this assumption teacher training plays a very relevant role and should be seen in a new perspective. We argue that a source for the designing of accurate teaching strategies is strongly related to the links between research, innovation and training. This triangle enables:

- . teachers to make a reflection about their practices in the classroom;
- . teachers to share their difficulties and their doubts with colleagues and educational researchers;
- . teachers to highlight their procedures in the classroom with a theoretical framework:
- . teachers to look for innovation within this framework rather than by chance:
- . educational researchers to define with effectiveness priorities for their research projects;
- . educational researchers to understand better the potential of the reflection-action methodology;
- . educational researchers to fit better their interests within "hands-on" difficulties;
- . students to be faced with more appropriate activities for achieving meaningful learning:
- . students to feel at the centre of the teaching and learning process.
- . teachers, educational researchers and students to comprehend the relevance of the constructivist procedures both in science classrooms and through the development of the teachers.

#### THE RELEVANCE OF TEACHER TRAINING

Dissatisfaction felt by teachers and students result from very different aspects; one of them is strongly related to the fact that most teachers taught basic concepts and definitions in a transmissive way and relatively little emphasis was placed either on applications of scientific knowledge or on the development of higher-order thinking skills. Therefore teacher education should be an area of indepth research and discussion towards alternative practices in the classroom. Three aspects which, from the authors point of view, should be take into account will be referred to below.

A. Through the last ten years it is possible to select from the literature the idea that science students reflect a lack of an epistemological dimension in the construction of their scientific knowledge. Neverthelesss if it is desirable that this view is achieved by the students it is vital that the teachers keep it with them; meanwhile the data which came from several pieces of research reveal that most teachers have a very poor background concerning this issue (Bileh & Malik, 1977; Carey & Strauss 1970). Mainly of science teachers practices are very close to the empiricist views of the construction of scientific knowledge rather than a modern position based on a constructivist epistemology (Praia, 1995). The "scientific method" is still presented as the only way for the implementation and growing of the scientific knowledge.

B. Practical work including fieldwork activities implemented and developed in sciences, particularly Earth-sciences classes is another important aspect which deserves a few words taking into account that it has been a distinctive feature of science courses for many years. There is of course, much variety of practices in schools. Nevertheless despite the enormous amount of development, implementation and a little reserch it seems clear that science teachers and educators have failed to provide a rationale for, and style of, practical work for school science teaching—that command wide consensus in the profession (Woolnough 1991). Despite the intrinsic difficulties most teachers are ill-prepared to teach effectively in the science laboratory taking into account that they have been brought up on a diet of content-dominated cookery book type practical work, and many got into the habit of propagation it themselves (Woolnough and Allsop 1985). The most important shortcoming is the way the students are faced with practical activities; in fact these activities are mainly presented in a non-problematic way and in a very demonstrative form. For all the above, changes should be discussed with teachers, particularly Earth-sciences teachers, and this procedure has enormous implications for preservice and inservice teacher education.

C. From the early 1970s, educational research, particularly in the field of science education, began to focus on the ideas which lie behind students' answers when they are faced with questions dealing with the interpretation of natural phenomena. Researchers using different tools of research attempted to describe and achieve an understanding of the way in which students conceptualize a range of scientific processes and events. In so doing the students provided interesting insights into their own world - a world often of compelling reasonableness (Driver 1989). The results of several years of research reveal that the learners held across differents areas of science such as Earth-sciences prior conceptions which influenced their further learning and frequently proved to be difficult to eradicate. Here is a powerful, reason for understanding learners' conceptions of science.

If one assumes that learning is always an interpretative process and always involves individuals' constructions so it is vital the designing of appropriate approaches to change commonly teachers' procedures. Constructivism is not an option to be invoked by teachers and students on particular ocasions or during a particular set of activities. Whether the teachers believe that students learn by constructivist processes influences the relations in the classroom and also the way activities are planned and implemented. It makes sense to predict a dramatic change of the teachers' role in the classroom when a constructivist epistemology is adopted (von Glaserfield , 1988). In fact the teachers' role will no longer be to dispense "truth" but rather to help and guide the students in the conceptual organization of certain areas of experience. From a constructivist perspective, the most relevant curriculum challenge for teachers is to focus on student learning with understanding rather than to stress content coverage only (Tobin and al. 1990).

#### ATTEMPTS FOR SHIFTING PRACTICES IN SCIENCE CLASSROOMS

The diagram of figure 1 displays the theoretical context in which it has been developed several attempts to help teachers and students to shift their practices in the classroom.

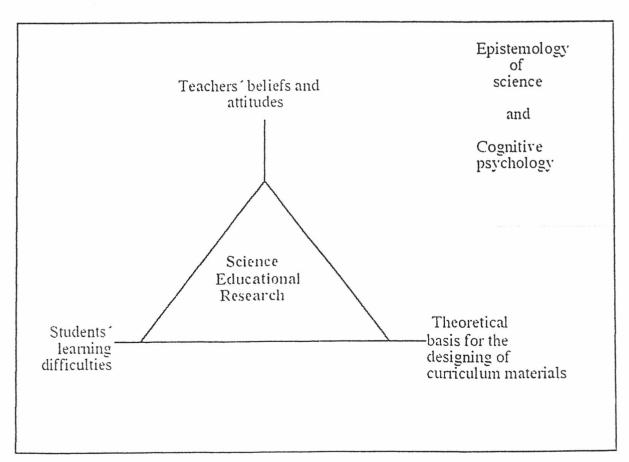


Fig.1 The theoretical context of science educational research

An explanation of the model, even telegraphic, needs to be done. The theoretical context of educational research in Earth-sciences is guided by suggestions which enumerge from cognitive psychology, epistemolgy of science, sociology and history of science. So, taking into account that the main aim of the teachers is to help students overcome some of their learning difficulties it is relevant to design appropriate curriculum materials in accordance with the guidelines of cognitive psychology and modern epistemology. The sociological context and the history of the construction of the scientific knowledge are particularly relevant, at least in some contents such as, continental drift, plate tectonics, development of life throghout geological time, location of the Earth in the Solar System. Nevertheless the designing referred to above is strongly related to teachers' beliefs and in this sense it is desirable to develop activities which show them that the still common empiricist views (Praia 1995) should change towards a more rationaliste one. This is the context in which a set of activities has been conducted, particularly in service training, during the last three or four years in Portugal.

#### Research Projects

The aim of these Research Projects is to influence teachers practices in Earth-sciences classroom. These Projects should be designed as it is revealed in diagram of figure 2.

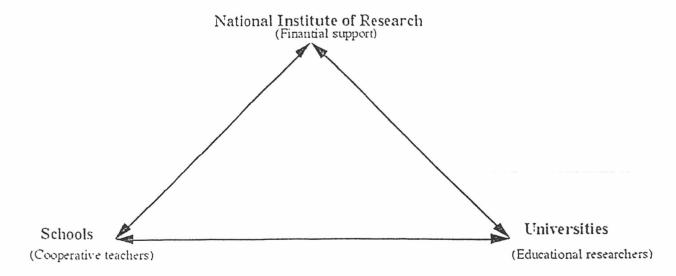


Fig. 2 The figure reveals the articulation between Universities. Secondary schools and the institution who provide the finantial support.

The participation of secondary school teachers selected in accordance with a particular set of criteria is probably the novelty of these projects. Behind this decision there are two important assumptions: first cooperative teachers are really involved in the research and at the

end the results belong to them rather than presented to them: secondly the disclosure of the results of the experiments is quite more credible for teachers if it is carried out by colleagues who work "hands-on" in the field.

As an example of activities within one of these projects we refer here the designing and implementation of the content Continental Drift. This strategy was developed in seventh grade and it was rooted both on modern views of epistemology and history of science and on constructivist perspectives of teaching. Some details will be referred to in section Workshops.

#### Workshops with science teachers

Three types of sessions have been carried out:

- A. The first one strongly related to presentation and discussion of activities previously implemented in Earth-science classrooms by cooperative teachers:
- B. The second one deals with presentation of lab activities and suggestions for the preparation of field trip activities:
- C. The third one related to the disclosure and discussion of results concerned with research works carried out in areas such as alternative ideas or the development and nature of scientific knowledge.

A. Workshops of the first type are mainly conducted by secondary school teachers who have been involved in the implementation of the activities in the classroom. The session usually starts with a short intervention of an educator researcher concerned with the theoretical context of the experience and afterwards a reflection on action by the cooperative teachers takes place. Materials designed, such as work sheets or written texts which have been used and, particularly, the way they were presented to the students are discussed indepth by all the participants. Shortcomings both of the materials and the methodologies should be identified by the teachers: if not, they are pointed out by the team responsible. It is desirable that alternative materials are designed or at least outlined. It should be emphasized that curriculum materials constructed by the teachers in projects of reflection-action are the cement of teacher training. One of these workshops related to the way the controversy between Permanentists and Mobilists about the Continental Dtift—was presented to the students (in accordance with the history of these subject matter) gave some interesting indications from teachers who have participated in these sessions. Their opinions seem to reveal strong agreement with the methodology:

This experience is completely different from previous ones. Before we came for listening. Here we are really engaged in the discussion and we have to look for solutions for problems

The planning of these sessions is an attempt to influence science teachers practices with recommendations which enumerge from differents areas of research in Earth-science Education.

B. The second type is quite relevant in Earth-sciences because it relates to a matter which has been underestimate in this area of knowledge. The way both practical work and field work have been developed and implemented are being rethinking. To engender a climate of inquiry rather than a demonstrative procedure is desirable. Afterwards subsequent discussions would lead to concept formation and understanding. Nevertheless a demonstrative procedure is still common in our schools.

A few examples of a set of topics which have been covered in these workshops are stressed here:

Sedimentary structures - practical activities suggested have two intentions: they can elicit a set of questions or they can be seen as sources of data for looking for answer to questions/problems previously shaped such as meaning of the recording of a particular structure i.e ripple marks.

Weathering and erosion - activities revealing that these are the main geological processes affecting the surface of the land; for example carbonates weather by completely dissolving. Situations related to everyday life such as deteriotation in monuments are used to elicit questions which should be discussed on the basis of the results obtained in the lab.

Origin of folds and faults - origin, nature and direction of forces which are recorded on the rock layers of the continental crust are interpreted through dinamic models constructed in the lab. Questions emmerging.

for example, from the origin or consequences of vertical or horizontal movements i.e. folding or faulting can be tested through several practical activities carried out in the classroom. It should be emphasized that behind each activity there is a very specific problem to be solved.

The way these workshops are conducted should be a mirror of the procedures we believe the teachers have to use with their students. This methodology provides interesting points for discussion among teachers and gives credibility to the constructivist way of learning scientific concepts.

C. The third type of workshops conducted by the research team start facing the teachers with, for example, sets of students' misconceptions previously identified about curricular topics. Activities asked for the teachers can be related to the discussion of the relevance and meaning of these misconceptions. Afterwards, reflections are suggested deal with common procedures of the teachers in the classroom which, eventually, reinforce some of these students' views. Designing of guiedelines of accurate activities for helping students to overcome these views are developed by the teachers. These strategies should also take into account aspects related to the development of the construction of the geological knowledge i.e. the relevance of the history. Other aspects such as: change and continuity are persistent features of science; testing, revising and ocasional discarding of theories never ends in science; scientists have trouble being entirely objective about their methods and findings should be included in the activities planned by the reachers.

#### FINAL COMMENTS

The efforts which have been carried out for improving Earth-sciences education in Portugal are based on two assumptions: teacher training and curriculum materials play a relevant role for changing the present situation.

A strong and dynamic group of well prepared teachers both, from a scientific and educational point of view, should be reached through an effective link between educational researchers from Colleges and Universities and secondary school science teachers. The planning and development of research projects involving educational researchers and science teachers, including phases carried out in the classroom, seem to be a very effective way to strengthen this link. There are indications that these projects enable, on one hand to highlight hands-on activities with up-to-date theoretical framework and on the other hand to develop reflection on action.

The designing of accurate curriculum materials by teams involving the staff of University Departments and science teachers is another very important tool for the implementation of this policy of change. Qualitative information picked up from experiences which have been developed reveal that teachers really appreciate to participate and to know the several steps of the construction of the materials rather than be faced with a package of activities which they should implement in the classroom. This procedure provides the teachers with quite useful background which grows from discussions, reflections, readings and particularly from the conceptualization and designing of activities for application in the school.

#### ACKNOWLEDGEMENTS

We are grateful for the finantial support provided by both Luso-Americana Foundation and Research Unit Didáctica e Tecnologia na Formação de Professores.

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