# Implementing Global Science Literacy

Edited by
Victor J. Mayer

This book follows the publication of *Global Science Literacy* (2002) by Kluwer Academic Publishers. It expands on the arguments for a new type of science curriculum in that book for the secondary schools of the world. Instead of being based on each of the major disciplines as are almost all current science curricula, it suggested that curricula should be conceptually organized around the Earth system, include the science methodology of the system sciences, and capitalize on the cross-cultural characteristics of science to assist in establishing greater understanding of the contributions of all cultures. The first several chapters of the present book add additional support to Global Science Literacy (GSL) as a viable international basis for science curricula. Chapters describe the characteristics of Chinese culture and compares them to GSL characteristics, discuss research on science in an indigenous culture and the implications for GSL, and summarize research on science teaching in the field and its implications for GSL. Additional chapters describe national science curricula of Taiwan, the Peoples Republic of China, Singapore, Korea, Germany and Spain and the conditions for implementing GSL in those countries. The last several chapters describe experiences and programs for developing teachers of Earth Systems Education curricula and those based on Global Science Literacy. Over twenty individuals from twelve different countries contributed their expertise to the chapters in this book.

The illustration on the front cover is from the National Aeronautics and Space Administration. It depicts a young John Glenn looking at the Earth through a celestial globe during his astronaut training. Glenn represents the best of a global citizenry. He served as a Marine Corps pilot, became the first astronaut to circle the Earth, went on to become a Senator from Ohio, and became the oldest active astronaut flying his last mission at age 77. He now serves at The Ohio State University in the John Glenn Institute for Public Service and Public Policy. He has received many honors. One of the most significant for his inclusion on the cover of this book was the receipt of the first outstanding service to science education award of the Science Education Council of Ohio, the organization of Ohio's science teachers. This award recognized his support of quality science education while serving as a Senator from the State. We would hope that science curricula and teaching in the future will inspire in students a love of science, the Earth it studies, and the people of all countries that inhabit Earth commensurate with that exhibited by John Glenn throughout his life. We believe that Global Science Literacy can be the foundation for such curricula and teaching.

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# CHAPTER 13: THE CHALLENGE OF GLOBAL SCIENCE LITERACY IN INITIAL EDUCATION OF PRIMARY SCHOOL TEACHERS IN PORTUGAL

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## 1. INTRODUCTION

Teacher Education in the University of Aveiro (Portugal) is concerned with science in the curriculum of future Primary School Teachers. The experience is not only described but also interpreted in a theoretical framework.
The purpose of this chapter is to describe an experience that is being carried out in three sections:

- The first, related to the context in which science literacy is developed and also with their role in the science curriculum of Teacher Education;
- The second provides an overview about Teacher Education stressing its guidelines, difficulties and suggestions;
- The third, describes and comments on the conceptualisation, the design, the implementation of a new science subject in the curriculum of Primary School Teachers.

Limitations of the experience during the process are finally referred to.

## 2. SCIENCE LITERACY AND TEACHER EDUCATION

### *2.1.science education as a component of global education for citizenship*

Social changes that are occurring all over the world since the end of the Twentieth Century have effects on life organization and also on the way information and knowledge are disseminated. The increasing rate of dissemination enables us to have a greater and more global awareness of what is happening across the world, in different societies with more or less contrasts. As far as basic educational needs are concerned these changes should be developed towards both a better management of the available resources and the search for solutions to international problems, such as: the overpopulation of the planet, the scarcity of food, the overexploitation of energy resources and of the sub-soil, the spreading of epidemics, the degradation of the environment, the drug traffic and so on. These problems require countries to act in a concerted way to maintain balance in the world (PNUD, 1999; 2000).

No doubt economic interests and political decisions play an important role for the solutions to these problems. Despite this, one cannot fail to take into account the scientific knowledge for an understanding of the respective causes and consequences. Nevertheless, science does not always elect the accurate solutions to these problems because scientific knowledge is rooted on finance dispensed by people and institutions that have not a healthy view of the natural world.

On the one hand scientific and technological development is neither linear nor independent from the dominant social and ethical values at a particular stage and, on the other hand, a scientific view of the world is not unique. However, in order to solve a great number of questions, the importance of scientific knowledge cannot be ignored. Only science can provide a basis from which the effects of technology on the environment can be evaluated; only science can help to find solutions for the safety of the planet. Finally, only scientific methods will allow sound judgments to be made on questions that are international, national and part of people's daily lives (Rutherford and Ahlgren, 1990; Hodson, 1998).

This is the framework that guides, through a scientific-technological component, the personal and social education of individuals. Therefore, it is suggested that every individual should have sufficient scientific-technological knowledge for the understanding of the important phenomena in the world. In addition, democratic decisions will be taken in an informed way and with shared social responsibility. This position, although a widely defended and accepted principle today, raises problems about the means and extent to which it can be achieved.

Even though formal education represents only one part of each person's access to information and global education, this does not diminish the responsibility he/she has in contributing towards social demands. The question then is that of defining the boundaries of scientific knowledge proper for the school context, in such a way as to contribute towards the individual scientific culture and as a foundation for each person to build on the development of this knowledge.

### 2.2 *Early science education in school*

The need to promote basic scientific-technological education for all since the first years of school has been a common theme for the vast majority of researchers and educators in the light of the above. It is from this perspective that it is argued that primary school will always have to create some understanding, even if simplified, of the process and nature of science, as well as the development of a scientific attitude towards problems (Harlen, 1992). One of the functions attributed to this school level is to promote useful learning that makes sense to the pupils, as opposed to the simple acquisition of facts that is still defended by some.

It is in this framework that, in recent years, the teaching of science has assumed an important position in discussions about school curricula and the educational reforms of the early years of schooling, primary and elementary education.

Science teaching has ceased to be concerned only with the education of an elite of specialists, and is now considered an essential component of the basic educational foundation of all citizens. "Science education for all" has become the slogan in recent decades and this area has been considered fundamental for the understanding of the world that surrounds us. Several writers have suggested it should be viewed as an education for scientific literacy and not as the training of future scientists. Sciences are a part of basic knowledge that all individuals should have in order to grow and live in developed societies today. At the same time, they are the source of a greater equality and a better social integration that our children should not be deprived of (Charpak, 1996).



Moreover, a better development of science teaching at elementary levels may even constitute an opportunity for the much-desired educational change at these age levels.

Interest in questions linked to teaching and learning in these matters is clear from the vast amount of research and literature which has grown up in this domain over recent years, as well as the large number of projects in curricular research, development and evaluation which have been carried out in several countries, as well as in international contexts (see, for example, NTCM, 1991; Osborne & Simon 1996; CIEP, 1997).

However certain dissatisfaction also seems common in relation to the results and effectiveness of the efforts made over recent years to improve the scientific education of the younger sectors of the population. In fact, research seems to show that in spite of all efforts and the significant presence of science in the curricula of almost all countries, sciences continue to lack, particularly in pre-school and primary education, a status equivalent to that of other areas of knowledge, for example, language and mathematics (Osborne and Simon, 1996; Charpak, 1996).

In spite of the growing awareness of this situation - accompanied by a recognition that we live in a society strongly marked by science and technology for which it is necessary to prepare the children and youngsters who live and will live in it for many years - it is a fact that the great majority of teachers are unprepared and insecure to face the new challenges (CIEP, 1997; 38). This has been confirmed by several studies. Cole and Collaborators (in Sprinthall and Sprinthall, 1993), for example, conclude, from a study on interaction in science classrooms, that 95% of the time, more than 90% of science teachers use texts and not direct experiments; oral explanations, short question-and-answer exercises and work sheets dominate. Problem solving in laboratories continues to be reduced to a minimum. Osborne and Simon (1996) also refer to several international studies in which a reduced adoption and dissemination of science teaching in primary education has been revealed. Besides the lack of material and equipment in schools, the recognition on the part of those responsible (school administrators and principals) of the importance of these school curricula is limited, and teacher preparation is inadequate. Other researchers have shown that the absence of science teaching in elementary levels is due, essentially, to the feelings of insecurity, anxiety and uneasiness which many teachers feel towards sciences, highlighting the need to develop positive attitudes towards this curricular area and give more confidence to teachers as indispensable conditions for the expansion and the development of science teaching in primary schools (Osborne and Simon, 1996; Charpak, 1996).

Insecurity, anxiety, lack of teacher's preparation, these are good reasons for understanding what is happening with fieldwork in our schools. This has to be emphasized, particularly because fieldwork activities, if designed properly, should be an attempt to provide a holistic view in natural sciences. Therefore learning about the natural world cannot be carried out without observation, interpretation, hypothesizing and explanation of facts and phenomena taking place at the natural environment. Fieldwork learning activities are recognized by their particular features and specific methodology. The methanol that should be used during the trips includes many groups and sub-groups discussions, the raising of questions, both by the learner and the teachers, the making of observations, the collecting and recording of data and the testing of hypothesis. All this should be taken into account in teacher's education in order to help them to feel much more confidant when they are faced with natural science teaching, even at primary level.

The determining importance of the teacher in the mediation of the curriculum and the impossibility of separating his/her thinking from his/her actions is recognized today (Shavelson & Stern, 1983). It is understood that, just as pupils have preconceptions which play an essential role in the learning process, and which must be taken into account when the teaching is being planned, so are teachers the bearers of a set of concepts, beliefs, habits and attitudes which influence their practice and which should therefore be taken into consideration when their teacher education is planned, be it initial or in-service (Furió Mas, 1994; Gil Pérez, 1994).

The way in which teachers interpret the curriculum and its alterations in times of change – which is strongly dependent on their personal theories about school, teaching, knowledge and learning and on their scientific knowledge – come to determine the teaching put into practice.

## 3. TEACHER'S EDUCATION AND PRIMARY SCIENCE CURRICULUM

Our students - future primary school teachers - will be teaching in the twenty first century and it is true that what teachers do depends on what is happening in the wider community. What teachers teach reflects the times in which they live. Therefore change is essential in education. In a rudimentary analysis, the teacher's job is first and foremost to ensure that the pupils learn. Nevertheless if this view covers a certain professional function, there are hidden perceptions of other not less relevant dimensions. Let us see that education is not only concerned with equipping pupils with knowledge and skill they need. It must help our youngsters to use leisure time creatively, have respect for other people, other cultures and other beliefs, become good citizens, think things out for themselves, and pursue a healthy life style (Dearing, 1994).

From the above, teacher's profile should be seen as corresponding to a person with a global perspective rather than someone only designing and carrying out activities in the classroom. Teacher education is therefore a topic of particular and in-depth reflex ion as an attempt to provide professionals of quality and able to play an important role, even in the definition of educational policies for the future. Documents recently published (CRUP, 2000)) have emphasized the indubitable relevance of rethinking Teacher Education in Portuguese Universities. The definition of main areas of competence and capacities for the teachers in general and science teachers in particular, is already been put forward (Araújo e Sá and Costa, 2000). In a holistic and interactive perspective of teacher's competences the following areas have been defined:

. Cultural, social and personal education related to the development of reflexion capacity, autonomy, cooperation, participation and open mind to different forms of contemporary culture;

. Scientific education concerned with the contents that should be taught;



. Pedagogical education dealing with self-reflection about educational problems of our present society;

. Development of teaching competences that should be integrated in the teaching practices in order to become able of developing accurate solutions for solving practical issues;

. Development of critical analysis capacities and attitudes, of innovation and pedagogical investigation towards the production of new knowledge and challenge of situations.

Let us go further and think specifically about primary school teachers and on their scientific education, particularly at University of Aveiro. At this school it was argued that, as far as science is concerned, the following four components should be considered:

. The nature and the meaning of science and their social and cultural context;

. The learning of science (global subjects rather than specific subjects);

. The learning of how to learn science;

. The learning of how to teach science at primary level.

The first dimension is an important one even at the primary level. The image that many pupils have of science and how it works is often distorted. The myths that our learners have about science are not dispelled when science teaching focuses narrowly on concepts and laws. To realize that it is necessary to overcome this view seems to be important.

The second dimension is particularly relevant when one talks about primary science curriculum, as it will be discussed further. What one bears in mind is to help pupils to start to understand broad concepts towards being familiar with the natural world.

No doubt, the third dimension is a difficult one in Teacher Education. There is no course at initial education that can teach enough science in order to get teachers well prepared for the future. Therefore, they must be motivated to involve themselves in future learning activities, as well as to interact with other teachers in schools.

Research studies (Frost, 1997) reveal, about the latter dimension, that the main purpose is to learn science as a whole and continuous process in a social context. To achieve this issue children must know:

. Things about the natural and made world;

. To understand explanations of how things happen;

. To be familiar with some scientific concepts;

. To ask questions about what causes things to happen and how people achieve in producing such explanations;

. To understand experiments, deciding about the procedures to find evidence for answering questions;

. To achieve an enjoyable relationship with the environment through field work activities;

. To feel that fieldwork activities are as relevant as classroom or laboratory practices as far as science teaching is concerned;

. To formulate hypotheses about the results; interpret data, understanding how data was collected;

. To classify, compare, observe, measure, record, describe, and manipulate objects and apparatus;

. To communicate ideas.

A final comment, in this section, about science in primary school curriculum (6-10 years old): *The Study of the Environment* is an area in which one can find Social Sciences, History and Geography. Moreover, the national curriculum does not stipulate exactly how science lessons should be conducted. Therefore, what in fact happens in the classroom is strongly related to the level of teacher knowledge about the subject and also to their skills concerned with science teaching.

Practical work plays a crucial role in science teaching, even at the level that we are talking about. In Portugal, nowadays, it does not make sense to comment on this important issue, i.e. practical work in schools, without giving a note about the Project *Ciência Viva* launched in 1996. This is a Project sponsored by the Ministry of Science and Technology rather than the Ministry of Education. Its main aim is to promote both scientific and technological culture in Portuguese society - a central concern of the national science and technology policies – and to create a greater understanding of science education in schools. Strategies carried out make an attempt at promoting the teaching of science through experimental activities assuming that they are fundamental to a lively learning of science.

The relevance of this Project for the amelioration of the equipment in the primary schools that are involved is great. At this stage schools can apply to the Project Ciência Viva through the design of a thorough plan of activities. Nevertheless this means that the teachers have to be well prepared in science and science teaching, something that must be also developed through in service training.

With this reference in mind, the teaching of science in the first school years must be based on pupil's experimental work, organized in a cognitive conceptual framework, in which pupil's ideas are a very important starting point.

## 4. GLOBAL SCIENCE IN THE CURRICULUM OF PRIMARY SCHOOL TEACHERS

### *4.1. An Overview Of Science Curriculum Before Global Science*

The aim of this section is to provide the reader with a perspective of science in the curriculum of students, future Primary School Teachers, in the foregoing period of ten years, before the designing and implementation of the subject Global Science. This curriculum was developed through a three years Course.

As a starting point, it should be emphasized that the idea of introducing science in this curriculum offered no discussion at all even at that time. The responsibles for the curriculum joined the campaign to make science teaching a part of the school curriculum mainly to improve the general welfare of society through education.

Nevertheless, science contents, during this previous period, were organised in the assumption that the students would gain a coherent and organised knowledge



of scientific principles through an understanding of the principles of each separate science field.

Therefore, a subject labelled Levelling Course in Science I (there was another one related to Maths) integrating four separately modules - Biology, Chemistry, Geology and Physics - was designed.

The modules, as a whole, took eight hours a week. They were conceptualised in a disciplinary point of view. An educator lecturer with a specific scientific background taught each module and, therefore, the contents were mainly related to a particular view of the area of knowledge, without appropriate links among them. In other words, the students were faced with a framework rooted on areas of knowledge rather than on a framework based on scientific themes. Practical activities, either in the laboratory or in the field, were also in accordance with the organization of the subject.

The lecturers, through the logic that each module worked like an individual unit, developed the approach in each module individually. The facts were taught as isolated information and it was supposed that it would be understood. As far as the assessment is concerned, it was also carried out in and individual way in each module.

Informal talks with the students reveal that most of them claim for unifying themes to organise the contents and, therefore, the approach that has been developed needed to be rethought. In addition the students complained about the length of the subject taking into account that, from their point of view, they had to prepare four subjects rather than one.

From the picture drawn above and also from the context of science education nowadays, described in the previous sections of this chapter, it is easy to understand that the team responsible for science teacher education, particularly at primary level, has recognised that an in-depth analysis of the science curriculum to future primary school teachers was crucial.

Discussions towards the designing of a new four years Course for Elementary School Teachers took place at Aveiro University in 1997. This situation created a very positive context to develop the analysis of the science area in teacher education for the students enrolled in that Course.

### *4.2. Global Science: How It Was Developed*

This section starts with a brief reference to the target audience of this subject. For the purpose of enrolling, students have to pass a test on Portuguese language. Learner's scientific background may be relatively different, i.e. there are a few who had science up to 12th level (secondary school) but, most of them, finished their learning of science at 9th level (compulsory school). Therefore, it is true to say that the majority of these students reveal weaknesses at the level of their scientific background. This is not a new or unexpected scenario, since it is well known that this situation is found in many countries (Charpak, 1996). It is an important point in our country because the primary school curriculum in Portugal is very demanding as far as science is concerned.

Considering both the previous experience described in outline and the theoretical context referred to at the beginning, the relevance of looking for an alternative to the way science is organized and implemented in the curriculum of primary school teachers is obvious.

The new subject emerged from two assumptions:

First of all, the designing of the syllabus should be carried out for helping students to achieve the development of attitudes, sensitivity and concerns for the improvement of the comprehension of the natural world.

Second, a holistic view of the relationship among facts and concepts towards the achievement of wider bodies of knowledge rather than a restrict view based on a long list of curricular items as a merely accumulative vision and a view of science out of context, is crucial.

These assumptions have been considered from the very beginning of the process, when the team responsible for the conceptualisation of the programme was organised. It was not an easy task to join together scientists from five different areas, particularly when teacher education and teaching are the issues under discussion. In fact, as far as teaching is concerned each scientific domain is usually confined to its own area with weak interactions with other areas (Costa et al., 2000). The existent links are developed at the level of management of curricular contents, rather than at the level of the conceptualisation and designing of the relationship between curricular concepts and also their corresponding approach.

Something different has occurred throughout this experience in relation to the team responsible for the designing and articulation of the contents of the Global Science. It was decided to get into the group, on the one hand, scientists and educators with a broad scientific background from biology and chemistry to geology and physics and, on the other hand, elements with a common view about laudable aims which help students to achieve a responsible citizenship through science education (Watts and McGrath, 1998; Hurd, 1998). The constitution of the team was as follows: four educators specialized in biology methods, chemistry methods, geology methods and physics methods, respectively, a biologist, a chemist, a geologist and a physicist. It should be stressed that the latter three were very keen on science education. The good personal relationships between the different elements of the group are an aspect, which should be stressed. This point and also a set of common concerns related to both teacher education and the relevance of science in Primary School teaching explains the availability of the lecturers for participating in this challenge, despite the amount of tasks they already were responsible for.

The main aim at the starting meetings was to reach a common denominator concerned both with the core concepts which should be taught and, particularly, with their relationship towards the achievement of a holistic view of the world. This was a demanding and very powerful exercise for each of the group participants, taking into account that nobody had already took part in a similar experience. Nevertheless, if on the one hand it was a fussy task, on the other hand, it was a very rich one from a personal and professional point of view.

Three main topics i.e. Sun, Earth and Life, emerged from the discussions that took place, as having a very high level of relevance and also a potential (for themselves and for the relations they establish between each other) to give a contribution for the understanding of the way our Planet works, as system of sub-systems (Mayer 1998).



Life, in a very broad sense, can be seen as the starting and final point of Science Education. Comprehension of the context and sustainability of Life on Earth and also the role played by the Sun, as a very particular source of energy seems to be crucial. Nevertheless, detailed information about the relationships put forward, is revealed in the diagram of Figure 1.

In fact solar radiation is, from a human scale, essentially undepletable and is also the most abundant source on Earth. This latter is a unique place, a dynamic system which is powered partly by the planets own internal energy but mostly by energy from the Sun around which it revolves (Merritts et al 1998). It should be emphasised that Earth's internal and environmental systems are strongly rooted in the way the Planet evolved within our Solar System.

The context referred to, before, in outline, was an accurate one for the development of Life. If it is not easy to provide a precise definition of Life: living organisms reveal some attributes, such as self-replication and capacity for self-regulation. A very complex framework responsible for the origin, development and maintenance of Life reveals that a very strong interaction of different factors was vital in the past, is still vital nowadays and will be vital in the future. Biodiversity is presented to the students as a relevant aspect of Life, based on the different organisation of the structural unit of living beings, which is the cell.

### *4.3 Functions of and approaches to science concepts in global science*

There can be no doubt about the importance of an accurate definition of the aims for the designing of any subject, and even for the approach selected. In other words, the aims contribute for the definition of the framework in which the implementation of the syllabus takes place. The following aims have been defined for the subject under discussion:

. To understand natural world phenomena, on the basis of principles emerging from different areas of scientific knowledge;

. To recognize both that the planet Earth is a well structured set of sub-systems in an in-depth and balanced interaction and that human beings are responsible for keeping this balance;

. To understand scientific issues in their historical, social and cultural context;

. To develop abilities and attitudes which enable an enjoyable science teaching and learning.

. Two different types of classes have been carried out - theoretical lectures and practical classes. The formers, are lecturer centred, despite the fact that students are frequently invited to participate by raising questions or putting forward their doubts. The themes are mainly presented in strong relationship with social and environmental issues. This is an attempt to help students to achieve a positive attitude about, for example, problem solving through the analysis of items that are geared to the subject area concerned, where there is a huge range of possible questions to be solved. The history and nature of science are also dimensions stressed during these lectures. It is assumed that once people gain a good sense of how science operates - along with a basic inventory of key science concepts as a basis for learning more later on - they can follow the science adventure story as it plays out during lifetimes (AAAS 1993).

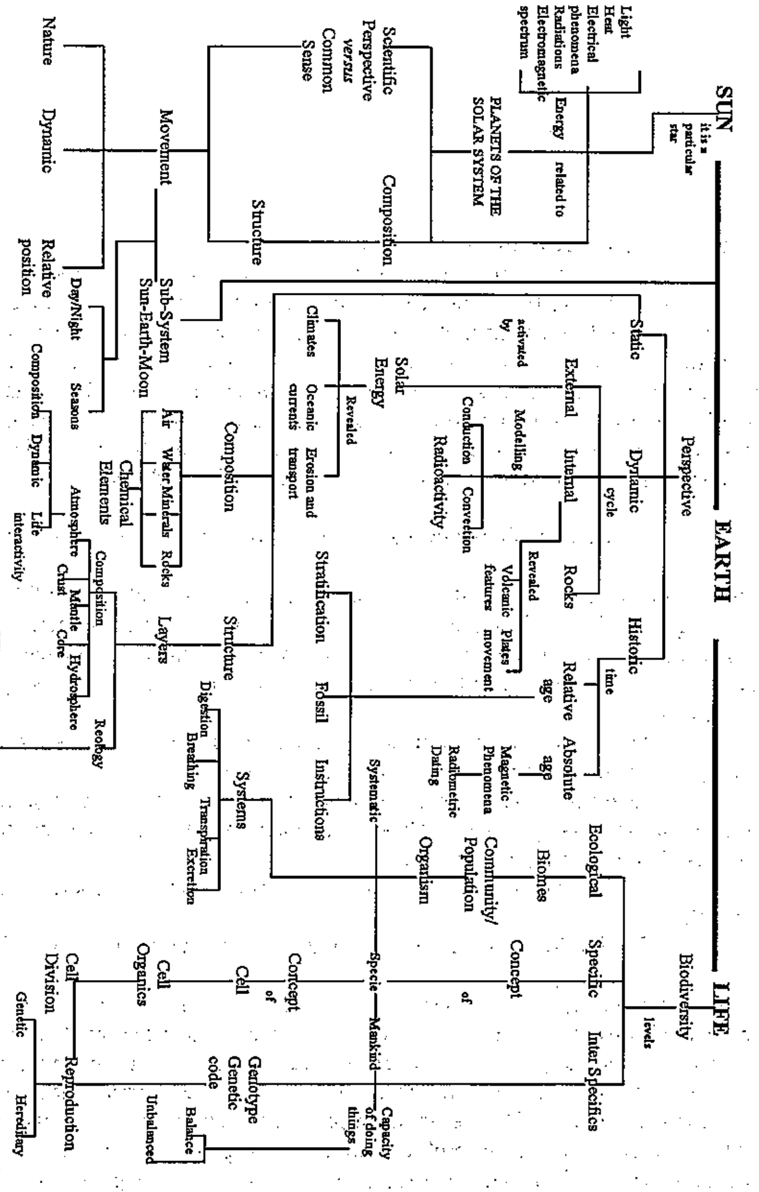


Fig. 1 – The figure represents a Conceptual Map showing the relationship among the different concept of the syllabus.



The approach of the different topics of the syllabus would be a very demanding task for only one lecturer and, therefore, it was decided to indicate a group of four, each one with a specific scientific background, for doing it. The group discussions have still continued after classes started and this enables us to decide, on time, which will be the person responsible for lecturing this or that class. Theoretical lectures take three hours a week.

There are no doubts that practical work is now widely accepted as an integral part of science education. Solomon (1980) has stressed this perspective by writing in relation to the role of the school laboratory as follows: "science belongs there as naturally as cooking belongs in a kitchen and gardening in a garden".

A set of assumptions presented below underlined the practical activities that have been designed:

. To maintain interest, satisfaction, open mind and curiosity;
. To define accurate methodologies for finding solutions for the problems;
. To help the development of skills of interpretation of data collected;
. To stimulate skills on communication.

Practical classes with 16-18 students, taking two hours a week, were carried out in the laboratory and an attempt was done to fit the nature of these activities with the topics that are presented at the theoretical classes. The students are organised in groups of four elements.

All the tasks started from a particular problem mainly presented by the teacher but, sometimes, put forward by the students. Nevertheless, it should be stressed here the three main phases occurring during practical work.

There was a first phase for the students to become aware of the problem. This means that they had to reflect on:

. The nature of the problem that they are faced with;
. The recognition of its relevance in terms of a way of interpreting the world, rather than a matter of how much is learnt.

A second phase is concerned with the planning of a procedure to investigate the problem. This is carried out in different ways with more or less interaction between students and teachers or among students. Nevertheless all of them are attempts to reach, on the one hand, the learning skills and science concepts, and, on the other hand, the learning of higher cognitive level aspects. Class discussion, group discussion and, sometimes, guided procedures are the strategies which have been used to look for the best methodology to find solutions for the problem.

A third phase is about the implementation of the plan that is close to the designing carried out before. The students, working in groups, carry out the preparation and making of the experiment itself and collect the data for subsequent analysis and interpretation. As far as rigorousness is concerned, the lecturer follows what is going on in the groups, making a careful supervision of the several procedures, helping students to recognise the relevance of being careful and being conscious that they are doing an exact task.

Interpretation of the data obtained from practical activities was carried out in work group. More or less in depth discussions took place among the students or with the lecturer. A particular attention is devoted to the analysis of cases related to the achievement of different results related to the same experiment. Attempts to look for explanations for these issues are developed.

At the end of the experimental activity, a small report was written by each group and provided to the lecturer for comments and analysis.

As stated before, the practical work, that we call experimental activities, was carried out in a laboratorial environment. We also think that field activities would be of great value in this cooperative learning process, if it is assumed that they are based on facts or events from our every day life. For example, when contents such as Sun/radiation/light (see Fig.1) are taught, the students come out of school and go to town looking for objects or aspects that can be linked with these topics. At the corner of a more or less busy street there is a convex mirror. Each group should raise questions, for instance, "why not a plane mirror?". From this elementary methodologies are designed to reach an answer.

Also, under this topic for field work, Global Science emerges - since they are dealing with light and sight, optical instruments are in order: to observe small living beings, to analyse some fossils in a rocky environment or to explain why they see a rainbow when it rains.

In a Global Science approach it is a challenge to look for field activities that can help students to understand better the strong link between natural events and our every day life. If it is true that observation is theory leaded, it is important to learn to observe and to collect data properly. Scientific knowledge doesn't star with observation, but doesn't exist with the lack of it.

In our curriculum of Primary School Teachers all these perspectives are taken into account and, therefore, laboratory and field activities are really environmental learning at different stages.

Let us see, for example, at least in outline, the nature and the context of the different laboratory activities with which the students were faced.

A. Three activities were designed related to one of the three main topics - the Sun -:

. Composition and features of the light coming out from the Sun; its behaviour on different types of surfaces;

. Types of mirrors and characteristics of the images they provide. Concave or convex mirrors are used in particular situations in our everyday life - looking for explanations;

. Dynamics of Earth and of other planets of the Solar System; interpretation of the different speed of the planets closer to the Sun and of the others. The starting problem was the succession of day and night and of the four seasons throughout the year.

B. The following activities were planned concerned with the other main topic, i.e. the Earth:

. Structure, composition and relevance of the atmosphere. The role played by the effects of acid rains that are a real problem of our society nowadays;

. Water as a crucial resource for the next century. Methods that are used in order to maintain water in appropriate conditions for mankind. Designing of a methodology for getting potable water.



. Rocks and minerals on the surface of the Earth; its origin and composition. Raw materials and its relevance. Analysis of cases revealing that industries, energy production, chemical processing, manufacture of building materials all depend on a steady supply of reasonably priced minerals, rocks and fuels. Social, political and environmental aspects are also involved.

C. One can stress the activities referred to below dealing with the last topic - Life:

. Life as a complex process at balance with natural issues. Preparation of an appropriate weekly diet for a school refectory; discussions take place related to a set of aspects which should be considered e.g. the age of the students, food properties.

. Labels concerned with different kinds of food and drinks provide an important amount of information. Different types of questions related both to the meaning and the students and the lecturer raise consequences of this data. Appropriate ways for solving these aspects are designed and discussed.

## 5. STUDENT'S VIEWS

The assessment concerning student's attitudes in relation to the experience that they were faced with was carried out through the administration of a questionnaire at the end of each academic year course i.e. 1999 and 2000. Through the analysis carried out so far, the following aspects can be already put forward:

. On the number of lectures attended - less than 25% of the students miss the lectures. But the number of students attending more than 50% of the lectures increased from 1999 to 2000;

. On the logic of the theoretical lectures - more than 50% recognize both the logic of the sequence of the topics that are being presented in the theoretical classes, and also their clearness. A quite small percentage, less than 10%, reveals an opposite view.

. On the purpose of the theoretical classes - more than 60% express the opinion that they understand reasonably well their objectives, although 25% of the remaining students state that they fully understand the objectives of the same lectures. Less than 5% couldn't see the evidence both of the objectives and the topics of the subject;

. On the articulation between the theoretical and practical classes, 80% of the students find that it is high. Less than 10% argue that the topics presented in the lectures are not related to the activities carried out in the laboratory;

. On the contents approached in the theoretical lectures, a large majority of the students, more than 80%, claim that they correspond mainly to topics which interest themselves and gave a contribution for a better understanding of the natural world. Less than 5% argue that the contents proposed do not provide relevant knowledge to explain the phenomena of the natural world and are not enjoyable.

. On the shortcomings of the subject; 30% of the students dislike the high number of lecturers involved;

. On the effectiveness of the bibliography provided, 50% of the respondents revealed satisfaction;

. On the level of complexity of the topics taught, 20% have the opinion that they do not offer difficulties. The remainder reveals an opposite view;

. On the scientific background, 35% of the students stress that they have a notorious lack of previous scientific knowledge concerned with the issues presented on the syllabus.

From this set of results, it seems clear that the overview of most students about the curricular contents and the structure of this new subject are mainly positive. The lecturers are analyzing the difficulties felt by the learners; attempts to help students to overcome those difficulties are made at this stage.

## 6. FINAL COMMENTS

All the authors of the chapter have integrated the team responsible for the conceptualisation, designing and implementation of this syllabus. Therefore, in a certain way, this document reveals their view concerning their perspective about the nature, the development and the potential of the subject under discussion.

Meetings with the lecturer's participant still occur for the discussion of a set of aspects that have to be improved, such as evaluation and bibliography available for the students. The team responsible is making an attempt to organise instruments for student's evaluation (for example, tests) that should be a mirror of the global view of science presented through the syllabus.

Appropriate bibliography for the students, reflecting the perspective that underpins the subject Global Science, is an important aspect not completely solved yet. The writing of appropriate curricula materials is a project that is starting to be analysed and discussed in more detail.

At the end, the authors feel that the acceptance of this challenge was a factor of great personal satisfaction, and an experience that is providing a new perspective in both scientific and educational areas. So, we would like to emphasize the importance of developing a broad and varied discussion with all colleagues from other institutions who are interested in this issue and have already been faced with similar enrichment experiences.

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