

The Promotion of Scientific Literacy with Alternative Methods and Activities. The experience of the Laboratorial Centre of Natural Sciences (EKFE) of Rthymnon

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Abstract. *Natural Sciences, even if they firstly attract, they also scare because in the consciousness of students they have been related with a high degree of difficulty and because their models of teaching are not the appropriate ones.*

This has as a result that the students who come out from the secondary education are, in a great percentage, scientifically illiterate. But also new schoolteachers appear to have important difficulties in the comprehension and application of Natural Sciences, as we have realised during in-service training seminars.

In the latest years, a change in educational models has taken place in Greece, which gives priority to experimental teaching and to the connection of sciences with their applications in everyday life.

The creation of EKFE helped considerably in this direction. The EKFE with a lot of alternative ways and activities enable the comprehension and popularization of Natural Sciences by the students and provide precious help to the teachers. Furthermore, with various European programs in which they have participated, they appear to contribute to the osmosis of pedagogic ideas and the transfer of modern and original theories and methods from other countries to their regions in Greece.

Keywords. Laboratorial Centers of Natural Sciences, scientific literacy, in-service teacher training.

1. Introduction

It is a highly admitted that Natural Sciences are exceptionally interesting and fascinating. This is rather attributed to the fact that they have an immediate connection to everyday life and provide – or at least they try to give - answers to thousands questions that a person may ask, both in theoretical and in practical terms. As a result, it is normal to expect that the students would

approach them with interest. However, the big majority faces them with fear, indifference, or even antipathy. There are various reasons to explain this behavior. Two of the most important ones, are their high degree of difficulty and the inadequate approaches of teaching.

However, are Natural Sciences really difficult, or do they simply appear like that because of the way they are presented? Undeniably, their comprehension presupposes a minimal base of knowledge of mathematics. This dependence on a subject usually considered as students' nightmare appears to be enough to create, from the very beginning, a negative attitude towards sciences. Furthermore, the type of language used to explain them in a written way is eminently symbolic; in consequence sciences are taken by students as a "knowledgeable" subject. It is really difficult for a teacher to convince them that the writing of $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2 \text{CH}_3\text{CH}_2\text{OH} + 2\text{CO}_2$ is necessary, in order to describe the creation of a divine gift that is called wine, while the $\text{CH}_3\text{CH}_2\text{OH} + \text{O}_2 \rightarrow \text{CH}_3\text{COOH} + \text{H}_2\text{O}$ describes its transformation in the "awful" vinegar.

In addition to these, the way of teaching, at least in the Greek school, puts particular emphasis in "theoretical elements", and makes the possibility of practising the natural Sciences really dislikeable. As a result, students turn their back to these courses and as they are taught in a misinterpreted, unfruitful way, they come out to be: "scientifically illiterate".

In order to find out solutions to this problem, questions as the following have to be answered: What is essential to teach to our students? How it will be taught? In conclusion, which type of student do we want to "form" at school? Students theoretically experienced and taught who will know how to solve scientific problems and how to form chemical equations, whereas they won't be able to distinguish whether in the

electricity bill we pay for the “power” or “energy” we finally consume? A scientifically illiterate student is a tomorrow's insufficient and depended citizen. A citizen who won't have the ability to interpret, to seek, to correct, to manufacture and to live in harmony with the environment. Furthermore, despite the fact that we are at the beginning of the century of a technological and a scientific boom, unfortunately compulsory education “produces” a paradoxically high percentage of “scientifically illiterate” young persons. Although young people are familiar enough with new technologies (PCs, mobile telephones, Internet, electronic games, etc.), they cannot interpret simple phenomena, manufacture or repair simple appliances, they are deprived of perceptiveness and after all they do not learn how to use scientific methodology in the resolution of various problems related to everyday life.

2. Characteristics of scientific literacy

I will present five characteristics of what we describe as “*scientific illiteracy*”, as these have been realised through specific activities and training experience that I have had in the EKFE of Rethymnon:

A -Insufficient ability of application of scientific knowledge: In the training seminars of new school teachers, we give them a lamp, only one cable and a battery and then we ask them to turn on the lamp. Above half of them do not accomplish it in the first 5 minutes

B -Insufficient perceptiveness: In another training activity, we give to young teachers of Natural Sciences, a box that contains a pencil, a rubber, two stones, a paper clip, a small photograph, a coin and a piece of copper, and then we ask them to observe with attention the contents of the box for one minute. Then we take the box away and we ask to describe its contents on a piece paper. A percentage bigger than 80% simply reports with one word, for example: “a pencil, a coin, a photograph etc.”. That is to prove that a very small percentage observes that the pencil was yellow, with black ruler and rubber, type HB.

C -Lack of accurate expression: I used to ask new schoolteachers the temperature of water at the boiling point. Most of them give a firm answer like: “in 100 degrees”. Less than 5%

are able to give a complete answer: “clean water” boils in 100 °C, when the pressure above it is one atmosphere”.

D -Difficulty of interpretation of phenomena of everyday activity: Some of the questions that I ask new primary and secondary are the following:

1. Why when cold water stays for long in a glass bubbles are formed on its walls?
2. Why when we open refreshments with carbon dioxide intense foam is observed?
3. Why food is cooked faster in a pressure-cooker?
4. Why when we pull a piece of thread abruptly it breaks easily, whereas if we pull it softly it doesn't?

New schoolteachers find difficulty in giving evident and completed answers to these questions. And it is difficult to teach properly Natural Sciences, when you cannot even realise by yourself their utilisation as a tool for interpretation of simple phenomena of everyday life.

E -Insufficient application of scientific methodology to discover a solution in various problems: We have realised incapacity in the analysis of a problem, its comprehension and in the articulation of simple steps which may lead to a solution. Here is a characteristic example: We give a thread, a metal weight, a meter and a chronometer and we ask them to measure the intensity of gravity “g” in the room, with 5 successive measurements. In this problem the most common weakness, which is observed, is the identification of the relevant natural law, or the “lesson” they will have to use, ignorance of the scientific equation that gives the period of the simple pendulum and the necessity of multiple measurements.

I referred to these examples because they are characteristic of the scientific insufficiency and lack of methodology that characterizes not only the students but also many of the teachers. This situation is a “creation” of an anachronistic educational model, inadequate to promote the charm of Natural Sciences and to provide students with essential knowledge and sufficiency of scientific resources. Even if we recognize an effort that has begun in the last 7-8 years in our country to change the educational methods, something that is also expressed in the contents of new school science textbooks,

however the road leading to the acquisition of a qualitative scientific literacy of young people still remains long. The contribution of Laboratorial Centres of Natural Sciences (EKFE) to this effort has been essential.

3. The contribution of EKFE to the development of scientific literacy of students and teachers

The *Laboratorial Centres of Natural Sciences* is a relatively recent institution in the Greek educational system. They were founded only 7 years ago and their main aim is to support the Laboratorial teaching of Natural Sciences in secondary education, but also in primary schools to some extent. Nowadays, 78 Laboratorial Centres of Natural Sciences are in operation all over the country and with a wide field of activities, they support substantially the scientific literacy of students in the field of Natural Sciences. Some of the activities of EKFE are the following:

- **the laboratorial equipment of schools,**
- **the training of** teachers of secondary education in the experimental teaching of Natural Sciences
- **the organisation of visits of Schools** in the laboratory Centres and the implementation of experimental activities by the students
- **the production of educational material**
- **the research** in the domain of teaching through experimental support
- **the application of innovative methods and new technologies** in the education etc.

In a framework of promotion of alternative methods of teaching in Natural Sciences, the EKFE of Rethymnon has advanced a variety of activities since 1997, which we present for reflection. More precisely:

1. We have printed out a manual of many pages of experiments of Natural Chemistry and Biology that is accompanied by a CD and videocassettes, which has been distributed to teachers. The selected experiments are simple and charming.
2. We have recorded and videotaped a lot of experiments that can be conducted with simple materials, in two units (Heat, Fluids). They have been sent to all schools of the prefecture of Rethymnon.
3. We have organised 2 weekly Mobility Programs of teachers training, which dealt

with the topic “*the Natural Sciences in the everyday activity of a person*”.

4. We have organised a European Program of Training of Greek science teachers in France, where apart from the briefing in the French Educational system they also had the opportunity to visit two worldwide recognised centres relative to the teaching of Natural Sciences: The *Vilette* (City of Sciences and Technology) and the Museum “*Palais des Decouvertes*”.
5. We have organised a school competition of projects and constructions, which had as a topic: “*Making use of alternative forms of energy*”.
6. We have recorded a big number of questions and answers that are related with the application of Natural Sciences in everyday life, which is offered as training material to the new teachers.
7. We have organised a lot of visits of students from Schools to the Laboratorial Centre dealing with “*experimental activities with simple materials*”.
8. We have presented educational software of the Natural sciences and simulations of experiments in the various schools of the prefecture of Rethymnon and we have educated science teachers in this software.
9. This year we have replaced a big number of Chemistry experiments with respective experiments in “micro-scale”. These were impressive experiments to students and also friendly to the environment.

We consider that through these activities, we brought teachers the students closer to the real meaning of Science. We helped them discover its charming side. Sciences became friendlier to their eyes, easier to approach. We presented the necessity of the knowledge of scientific laws and their application in our life. Finally, we tried to teach the students how to think practically: they ask, search, discover, interpret and manufacture. In other words, acting rather than accepting. They have learned not to be only receptors but also transmitters of messages simultaneously. We vision an intergraded education which will have “the active students” as a centre together with their scientific literacy. However, let us make the beginning. After all, in this place, thousands of years ago, it was believed that “**the beginning is half way through all**”.