

# THE TEACHING OF ENERGY IN EDUCATION

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**Abstract:** This article aims to feature the contribution of Environmental Education (E.E.) to Renewable Sources of Energy (R.S.E.) and energy saving. Particularly the goal of this study is to examine whether the role of E.E. can be catalytic, in order for everyone to realize the importance and necessity for R.S.E. in all sectors and manifestations of our life. In this respect we attempt to outline the character of E.E. and the procedures followed during materialization of its programs.

Through the need for change of human attitude towards the environment on one hand and the value system of our society on the other hand, education can play an important role. Overcoming the anthropocentric perception of the environment and the recent understanding of technology as an effective tool and means for dealing with worldwide environmental problems, rising on a daily basis, are rendered more and more significant.

This article concerning E.E. and its contribution to R.S.E. and energy saving constitutes an attempt to highlight its importance. Besides it takes upon the major subject of the necessary change of the traditional and established mentality of educational practice, which considers students as passive receivers who aim at the accumulation of knowledge, and focuses on the active participation of the individual for mastering and constructing knowledge, developing values and forming attitudes while the teacher acts as an assistant and supporter of their every step and action.

It is not our ambition to develop or evaluate specialized applications of R.S.E. neither we attempt to fully cover the issue of the introduction of R.S.E. to education. This issue had better be discussed in the overall framework of incorporating R.S.E. in the school curricula through the spectrum of the modern technological developments and become the subject of a more through and profound search.

Further study and experimental research are definitely required in order to define and further clarify the above issues.

**Keywords:** Environmental Education, Energy, Renewable Sources, Curriculum, modern technological developments.

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## I. INTRODUCTION

Energy is a fundamental, abstract but also significant scientific concept that enters into all individual subjects of Natural Sciences and Technology and consequently its teaching becomes necessary. While it is one of the most difficult concepts for students, its knowledge is essential, since it is related not only to many phenomena of everyday life, but also to intense social problems such as, for example, issues of energy conservation, renewable sources, the topical of the greenhouse effect due the overconsumption of fossil fuels for energy production, the poverty of developing countries, etc.

According to PISA program [1], PISA 2000 developed by the OECD the period 2000-06, in order to fight the scientific and technological illiteracy, scientific education includes a set of scientific knowledge and skills, such as the understanding of

basic scientific concepts such as conservation of energy, etc. Indeed, energy transformations are considered one of the 13 main scientific subjects, which in turn are one of the three components that determine the content and the framework of student evaluation, a framework that our country has also accepted.

Most physics books mention in their introduction that it is difficult to clearly define the concept of energy. That is, there is no universally accepted definition for energy in higher or secondary education [2, 3] although everyone agrees that the definitions of this abstract concept should start from its basic property of being conserved. However, in most textbooks of physics it is referred as "the ability to produce work" [4], while in another significant number of approaches energy is defined as "the ability to cause changes" [5].

## II. THE CONCEPT OF ENERGY

In many curriculums and teaching guidelines for the first two levels of education, the nature of energy is approached in at least three ways or combinations thereof.

In the first, Energy is considered a measurable quantity. In this accounting approach, Energy is simply considered a quantity that can be measured before, during and at the end of each of the many and different changes that occur in nature.

A second approach considers Energy not so much as an abstract concept, but an actual entity that can change form in many ways (polymorphic entity).

Finally, the third approach treats Energy as a kind of fluid whose nature is unchanging whether it exists in a hot object or in a moving one. In the various processes Energy is transferred from one place to another, without changing its nature. What's changes is the way it is transferred and the Energy remains just... Energy.

### *STUDENTS' OPINIONS ABOUT THE CONTENT OF THE CONCEPT "ENERGY"*

According to the findings and research of the Teaching of Natural Sciences mentioned in the international and Greek literature [6], the alternative views and the most important difficulties faced by students of all levels of education, but also by teachers, at least of the first education level with the concept of Energy are that:

- They recognize Energy as a property rather than a measurable quantity.
- They confuse the concepts of conversion and transfer or otherwise the forms of energy with its transfer processes.
- They confuse and do not understand the concepts of work, heat and power.
- They identify energy with movement or with an overt activity.
- They do not understand the storage of energy in mechanical phenomena.
- They consider that energy is depleted and not conserved (as long as it is used) or, after being conserved, it can be used again. While they can formulate the Conservation of Energy Principle (CEP), they cannot apply it to simple problems and don't use it as an explanatory tool or as a way of analysing physical systems.
- They do not understand the flow of energy and the energy chain.

It seems that despite the organized and systematic teaching of the concepts and laws of energy to students of all levels, alternative views remain strong and resistant to attempts to change them [7]. Perhaps this is partly due to their cognitive development. The conclusions of a research carried out by Liu and Mc-Keough [8] showed that the cognitive development of students seems to put a limit on learning and the formation of energy concepts, while an important role is still played by the didactic approach and teaching. Besides, students' views on energy constitute various models [6, 9]:

- The anthropomorphic or animistic model. In this model, energy is considered to be essential to life, that is, it is associated with living beings or the rendering of human characteristics to objects.
- Energy as an "obvious activity", which is identified with the external observer activity of some bodies.
- The storage model. Some objects are considered to have energy and they can reset energy. The energy is regarded as the causal factor stored in specific objects.

- Energy as an ingredient. Energy is a latent property or component of bodies and needs some cause or trigger to be released.
- Energy as a sub-product of a situation. The energy is considered to be produced, and associated with the action and disappears.
- The "functional model" according to which energy is a very general type of fuel.
- The "flow transfer" model, in which energy is regarded as a liquid, or substance that flows from one to the other.

Various teaching approaches have been proposed to tackle the difficulties that face children of understanding regarding the concept of energy. The most appropriate is the introduction of energy through the study of energy chain examples [10]. In this approach, however, there are problems with the systematic description of many and varied phenomena.

To better address the related issues, we believe that modeling is necessary in order to separate the phenomena involved at two levels:

1. With the model of energy transfer
2. By visualizing the energy at a qualitative and quantitative level with the appropriate educational software.

### III. EXAMPLES OF PRIMARY EDUCATION PROGRAMS

#### *Indicative Work Plan in Primary Education*

The Program refers to Energy and its forms, as well as its applications on a local, national and global scale.

The treatment of the subject is divided into two parts. In the first, the students' actions are focused on the study and recording of renewable and conventional sources of energy. They study the alternative forms of energy, record the advantages and disadvantages of using each form and search their application in Greece and worldwide. They evaluate conventional sources of energy and study the problem of natural resources depletion.

In the second, with the help of a questionnaire, they conduct a survey on the topic of energy consumption in their daily life. More specifically: they calculate the electricity they consume every day at home, they are informed about the usefulness of home insulation, they calculate the loss of thermal energy from parts of the house and they are made aware of the issue of saving energy.

The survey questionnaire is indicative and jointly decided by the students and their teacher. At the end, the students compare their results, evaluate their conclusions and compose the final report of the work.

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#### *Subject selection criteria*

The topic of energy is always relevant and interesting. It presents the advantage of an interdisciplinary approach and therefore gives the opportunity for the involvement of many actors, both the school and the local community. The implementation of the Program has a rich communication dimension.

The concept of energy is included in the Curriculum of the Primary School, but also of other subjects. It also has a permanent character in Curriculums due to the interest it shows in many academic subjects.

The issue has a local, national and global dimension. It is offered for collecting and exchanging information, processing and drawing conclusions. It has a rich conceptual framework.

Both Greek and international research offer important findings regarding the students' mental patterns of the concept of energy [11].

***Indicative Methodological Framework for the design of the Program: "Energy, forms and applications of energy"***

Highlighting the topic. Material collection from the press, television and magazines related to energy in our society, heating, electricity and energy consumption.

Informing the students about the energy problem, discussion in the classroom with the help and coordination of their teacher.

The opinions of the students regarding the subject to be discussed, as well as their familiarity with the scientific terms they will encounter, are detected through a questionnaire.

***Goal formulation***

The students should:

- Identify energy sources
- To separate renewable energy sources from conventional ones.
- To establish that the sun is the primary source of energy.
- To recognize the advantages and disadvantages of alternative forms of energy.
- To mention geographical regions of Greece where alternative forms of energy can be exploited.
- To raise awareness of energy consumption.
- To acquire a positive attitude and behaviour towards the problem/issue of saving energy.
- To calculate the loss of thermal energy in their home.
- To record the factors that affect the loss of thermal energy.
- To calculate the electricity they consume in their daily life.
- To relate the concepts of Natural Sciences to everyday life.
- To raise awareness of the energy problems of the local community.
- To record the negative effects of energy overconsumption.
- To recognize the contribution of the History of Sciences to the problem they are studying.
- To associate literary texts with the energy issue.
- To cultivate a spirit of cooperation and responsibility.
- To practice in research methodology.

**Method:** Student-centered – Group-centered, Interactive – Interdisciplinary.

**Sources:** Encyclopedias, media, Internet, printed material, photographic material, CD-ROMs, Center for Renewable Energy Sources (CRES), Scientific articles.

***Teaching Activities***

- Division of students into groups.
- Recording the forms of energy and choosing from the groups of renewable and conventional sources to study.

- Extracting information from books, magazines and the internet.
- Exploration from biology and literature, of the view that the sun is a primary source of energy. Without the sun there would be no life.
- Visit to an alternative energy production plant, if available.
- Photographing and making albums by the students with a corresponding theme.
- Conducting research on energy consumption.
- Creation of a research questionnaire on energy consumption at home.
- Conducting the research by the groups with the help of the local community, the students' families and the teachers.
- Comparison of individual and group research results.
- Writing a report with the results of each group.
- Writing a comprehensive joint report of all students.
- Recording the results with the help of PC.

#### ***Arrangement of the work***

- Collection and processing of the first phase material from all groups.
- Processing of research results of each group and composition of work per group.
- Processing of the research results concerning energy consumption in daily life by all groups.
- Production of printed and electronic material with conclusions and research results.
- Highlights and suggestions for solving the problem of energy overconsumption.

#### ***Presentation of the work***

Determination of the day when the presentation of both the informative and photographic material, as well as the research results, will take place.

#### **Electronic presentation of the work**

**Evaluation criteria:** The composition and presentation of the work, the degree of achievement of the objectives, the methodological and interdisciplinary approach, the number of sources selected and the local authorities.

**Notification:** On the initiative of the students, the final results of the work are communicated to the local community.

## **IV. CONCLUSION**

In recent years, at the European and global level, particular importance has been given to the organized information of students about Renewable Energy Sources and Energy Saving, because as it is believed, informing and raising people's awareness from an early age ensures the existence of energy-responsible consumers in the future. The role of the School and consequently of the teachers is decisive for the success of this project.

Also, the role of the energy education of teachers, as well as their training, is decisive as they have the ability to raise awareness among their students and contribute to the formation of the appropriate consciousness and behavior of the new generation towards the energy and environmental problem. Their efforts are expected to have multiplicative benefits, since the sensitized students today can decisively influence, in turn, the people in their environment (parents, friends, relatives, etc.), and in the future become tomorrow's responsible citizens.

According to Gambro and Switzky [12], the public should be environmentally informed in the hope that increased knowledge and understanding of environmental problems will lead to more responsible behavior towards the environment. The best and most appropriate way, however, to educate an audience is through education. Both primary and secondary education are the first opportunity to achieve the aforementioned through the formal structures of the educational process.

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