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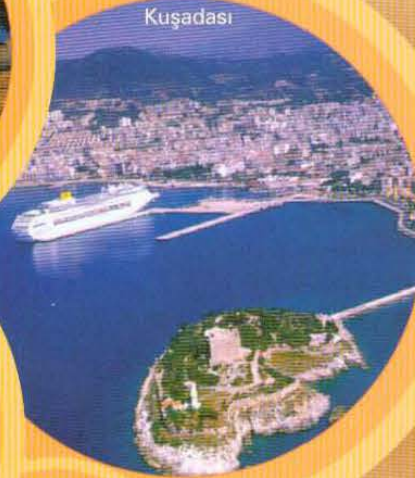


**Proceedings of the XIII. IOSTE Symposium on
The Use of Science and Technology Education
for Peace and Sustainable Development**

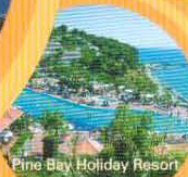
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21-26 September 2008

Pine Bay Holiday Resort - Kuşadası - TURKEY

Organized by
Buca Faculty of Education, Dokuz Eylül University - İZMİR - TURKEY

SUSTAINABLE DEVELOPMENT ISSUES IN TRAINING OF SCIENCE TEACHERS

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▼ ABSTRACT

The human use of natural world caused a variety of environmental problems, which affect entire world nowadays. We are currently in a situation of *planetary emergency*, marked by an array of very serious problems that are closely related: pollution and environmental degradation, depletion of natural resources, unsustainable demographic growth, extreme inequalities among different human groups, destructive conflicts, loss of biological and cultural diversity... As the hope is education - the cheapest and the most effective way of environmental protection, the United Nations General Assembly, given these serious problems, has adopted a resolution establishing a *Decade of Education for Sustainable Development (2005-2014)*. Taking this into account in our pre- and in-service science teachers training we started to stress the importance of changing their awareness towards the sustainability in development. Despite designing and testing data loggers for monitoring of noise pollution, IR, UV and ionisation radiation as well as ultrasound and infrasound waves, together with teachers we elaborated some educational materials concerned with education about, in and for environmental education as: Almost everything about water (which consists chapters on water pollution, protection and saving), Global warming, Hazardous waste, Ozone depletion, Energy in the environment, Environmental noise, Electromagnetic fields (including microwave and UV) as well as ionising radiation interactions.

Furthermore, the general Polish competitions for educational projects of science teachers on "*Radioactive world*" as well as "*Education for Sustainable Development in the Local Environment*" under the patronage of National Ministry of Education has been designed, executed and evaluated. In this paper the details concerning the methodology and results of the above mentioned activities are reported.

KEY WORDS Sustainable development, environmental education, teachers training, educational projects

1. INTRODUCTION

The world today is either in the early stages of an Environmental Revolution or the verge of environmental collapse and economic decline. *Our Planet is at risk!* The

trends are grim: many plant and animal species are being extinguished each day, the protective ozone shield over heavily populated areas is thinning, fossil fuel burning release billion tons of heat-trapping carbon dioxide into atmosphere (causing a greenhouse effect and as the result - climate changes) and the acid rains fall down (Brown et al., 1992, Berenfeld B., Tinker R., 1995, Enger E.D., Smith B.F., 2000). Is it the answer to the question: "What is the price of a rich life?" Additionally, the world population is growing by about 100 million people annually, equal to adding about another Mexico each year - the global population of world will double within less than 40 years. What to do?...

Nobody doubt - *the hope is education* - the cheapest and the most effective way of environmental protection. We already know what we need to do, we already have the needed technologies. However, unless more societies mobilize in support of *the Environmental Revolution*, it will not succeed. The policy decisions we make during this decade will determine whether our children live in a world of development or decline.

Taking this into account *the Agenda 21*, the *Rio Declaration on Environment and Development*, and the *Statement of principles for the Sustainable Management of Forests* were adopted by more than 178 Governments at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, June 1992. In article 36.12 of this Agenda we can find the following statement: "Training is one of the most important tools to develop human resources and facilitate the transition to a more sustainable world (...)" In addition, the United Nations General Assembly has proclaimed recently a resolution establishing a *Decade of Education for Sustainable Development (2005-2014)* and proposed a campaign entitled: "Education for Sustainable Development: necessary commitment" (<http://www.oei.es/decada/>).

The activities presented in this paper are going to support this valuable initiative by trying to follow the educational philosophy based on making science teachers aware on: Why? (the purposes of education) What? (the content issues) and How? (the applied methods) the education for sustainable education should be accomplished for secondary school students.

2. INTERDISCIPLINARITY IN SCIENCE EDUCATION FOR SUSTAINABLE DEVELOPMENT

It isn't easy to determine the beginnings of interdisciplinarity. Some people claim that this idea can be applied to the ancient works of Plato and Aristotle. Also such scientists as Leonardo da Vinci, Nicholas Copernicus, Galileo Galilei, René Descartes, Isaac Newton and Albert Einstein can be named "interdisciplinary thinkers". Contemporary science due to the continuous changes of correlation between its area of studies and mutual interactions of different disciplines with difficulty could be developed within traditional scientific disciplines. Interdisciplinarity proved to be valuable tool to cross the barriers separating disciplines and investigate scientific problems in a new light (context). In that way such sub-disciplines of physics, mathematics, biology, chemistry and geography as biophysics, biochemistry, astrophysics, geophysics, physical chemistry, astrobiology, biotechnology, ecology, mathematical and statistical physics, etc. have been created.

The contemporary information society has much more possibilities to fuse the knowledge from different disciplines. The new problem-based global information systems are generated as for example DENIS (the Development of Science Information System), INIS (the International Nuclear Information System), AGRIS (Agricultural Information System), etc. It doesn't mean however that a disciplinary approach will not progressive any longer. Disciplinary as well as interdisciplinary approaches are needed for the sustainable development of the society and should complete each other.

Environmental science is an interdisciplinary, complex study that describes problems caused by human use of the natural world and seeks remedies for these problems. The education for sustainable development of our world maybe of a great importance, and it became to be the dominant educational idea in 1990s. This idea is based upon the term of environmental education, which is now defined as an *interdisciplinary, integrated process* concerned with resolution of values conflicts related to the man-environment relationship, through development of a citizenry with awareness and understanding of the environment, both natural and man-altered. Further, this citizenry will be able and willing to apply enquiry skills, and implement decision-making, problem - solving and action strategies toward achieving/ maintaining homeostasis between quality of life and quality of environment. Uses of the term *environmental education* can be classified into education *about the environment, for the environment* (the preservation of) *and in the environment*.

Thus, science education, by using different methods and tools for the interdisciplinary studies of the word outside the classroom, should be strongly connected with the education *in the environment* (Lucas A. in paper Dillon J.,1996, Turlo J., Berndt M., Wichrowska H.,1993).

3. ENVIRONMENTAL AWARENESS OF SCHOOL STUDENTS

Motto:

*We can't care about things,
which we don't understand*

Barbara Ward

Sustainable development issue was not formally included in our obligatory science curriculum. However, to study the knowledge and environmental awareness of students the pilot test containing 30 sample open questions concerning the ecological "hot points" in Poland has been performed on the population of 419, 14-15 olds and 108 16-18 years old students (Turlo J., Wichrowska H.,1995).

As follows from the answers to the particular questions, the general, local environmental problems were familiar to the secondary school pupils. Most of them knew notion "air pollution", "ozone hole", "acid rain", "catalytic conversion", "ecological agriculture" (the proper understanding of the ecological agriculture was demonstrated by 94% of 16-18 years old, but only by 39% of 14-15 olds). Nevertheless, the understanding of the above notions among investigated students was far from being satisfactory and some of the lower secondary school students were writing, that

"ozone hole" is a big hole in the sky, which is UV radiation transmitting" or "it is the place between the earth and ozone layer". About 50% of lower secondary school pupils and as much as 90% of higher secondary school pupils could define the concept of greenhouse effect, but only 18% (lower secondary school) and 66% (higher secondary school) was able to relate this effect to the deforestation process. It was found, that some of 14-15 years old pupils knew only about small vegetables greenhouses situated near their homes! Also almost all investigated students were not able properly describe the basic sources of food contamination. But, it is understandable, that most of them indicated the Chernobyl nuclear power plant catastrophe as the most devastating to the environment, but no Hiroshima and Nagasaki nuclear bomb explosion. Thus, It was surprising to learn, that in this country with the eastern border situated at a distance of about 250 km from Chernobyl most of the respondents regard the Chernobyl catastrophe as the most dangerous ecological disaster, yet almost nobody could answer the question: "what are the naturally occurring radioactive elements in our environment?" Furthermore, only few knew about production and application of biogas and whether switching off the artificial lights brings only economical advantages, and about 30% of all pupils were aware of the necessity of water protection in Poland. This signified, that that there is a lot to do in Poland in order to increase the proper understanding of the sustainable development idea.

4. EXAMPLES OF PRACTICAL ACTIONS TOWARDS ENVIRONMENTAL EDUCATION OF TEACHERS

Taking into account the results of the above mentioned investigations we were forced to postulate the urgent need to pay more attention to the environmental issues education in Poland nowadays, as it has happen already in many western countries (Reid A., Teamey K., Dillon J.,2002, Reis G., Roth W-M.,2007, Cotto D.R. E. et al., 2007, McNaughton M.,J.,2007).

As we are dealing with pre- and in-service teachers training, and taking into account, that first of all we have to change the awareness of teachers towards the importance of sustainability in development, we started with designing an University computer-based "pro-ecological science laboratory" to promote more environmental friendly activities among the students, especially the science teachers to be. Few different ways of monitoring environment parameters by hands - on experiments (with the use of data loggers) have been proposed. For example: measurements of naturally occurring radiation doses using constructed by us a school type of Geiger-Müller counter working on-line with the computer, monitoring of noise pollution as well as ultrasound and infrasound waves (the infrasound detector was also designed, produced and supplied with dedicated software by us). During the course of laboratory work our future science teachers can also check the effectiveness of filters in respect to UV radiation, model the "greenhouse effect", investigate the quality of water (contamination due to the artificial fertilizers and certain pesticides) with potentiometer method using ion selective electrodes.

Furthermore, together with network of teachers from the Polish Association of Science Teachers, we developed *some interdisciplinary educational materials* on: Air

and Water Pollution, Global Warming, Hazardous Waste, Ozone Depletion, Energy in the Environment, Environmental Noise, Electromagnetic Fields (including UV) and Ionising Radiation Interactions. We published also the author's curriculum on: "Protection and Management of the Environment" (Turlo J., ed., 1996).

But, the most valuable (in opinion of science teachers) is the content of the book: "Interdisciplinary science projects (Turlo J. ed., 2001). This book contains the descriptions of 11 interdisciplinary science projects: Sound and music, Environmental noise, Energy in the environment, Non-conventional sources of energy, Climate and weather, Physics and animals, Electrostatic problems in everyday life, Colours, natural and artificial dyes, The use of Doppler's effect in science and technology, Cosmos through numbers, Man in space, Evolution of the Universe. Following the STL materials philosophy (Holbrook J. and Rannikmae M., ICASE) all these units have very clear structure; they consist of: introduction, objectives (general and operational) needed concepts and resources, guide for students (specifying all proposed tasks), guide for teacher (describing teaching strategy, including procedure of achievement of attainment targets, and evaluation strategy) and some supplementary information (if needed) in the particular case.

Let's analyse the exemplary project "Environmental noise" from the point of view of interdisciplinary education for sustainable development. This unit consists of 5 modules: "Noise-what it is?, Is noise affecting our health? Noise in our environment, Can we avoid noise? Ultrasound and infrasound - their existence and applications. These comprehensive educational material can be used to exemplify fusion of content from different disciplines: physics, technology, environmental science, music, biology, chemistry, geography, mathematics and also literature, history and religion due to the issues:

- ❖ physics: sources of sound, different kinds of sound and their characteristic measurements of frequency and intensity of sound - legal units;
- ❖ technology: noise in industry and transportation, health and safety-at-work, using of soundproof materials (how to avoid school bell noise);
- ❖ environmental science: reaction of human to the intensity of noise, standing of soundproof screens (planting of trees and bushes), requirements for zones of silence;
- ❖ music: listening of music e.g. classical, contemporary (disco music, heavy metal), source of noise (cacophony);
- ❖ biology: structure and functioning of year, hearing defects and their corrections, human health and noise effects, noise as an indicator of danger;
- ❖ chemistry: methods of cleaning using ultrasound in technology and medical applications;
- ❖ geography: regions with different intensity of noise, areas with zones of silence natural reserve, national parks;
- ❖ mathematics: calculating of the intensity of noise, plotting and reading of graphs, data processing and analysis;

- ❖ literature: spelling (phonetics), noise in the literature (noisy heroes), Horacy, Kant, Goethe - wrote about heavy noise, Dante called noise physical torture - "discovery of devil";
- ❖ history: How people defended themselves against noise in the history (putting the straw on the streets), torture of bell noise, roman law of building (100 B.C.), Sybarites - the 6th century B.C. - their noise disturbed a rest;
- ❖ religion: holy bells, walls of Yerycho.

In addition, following the important sentence relating to the environmental education: "Think globally, act locally" (Enger E.D., Smith B.F., 2000) the general Polish competition for educational projects of Polish science teachers and their student on "Radioactive World" and "Education for Sustainable Development in the Local Environment", "under the patronage of Polish Ministry of Education has been designed, executed and evaluated.

The first competition under the general title *Radioactive World* (Turlo J., Przegiętka K., Szűzewski, K., Turło Z., 2004) has been organised on behalf of the 100th anniversary of Maria Curie-Skłodowska Nobel Prize. The Award Committee received 44 projects from upper and lower secondary schools. Knowledge and methodical level of all projects was very high. Most of them engaged not only the science subjects teachers but also specialists of literature, history and arts. The Committee awarded 15 projects, which were the most original and their results were presented to the wide local community by press, radio and TV. The results of the best projects: original lessons plans, posters, WWW pages and computer animations were presented at the conferences and workshops, published in booklets, journals and placed in our Web page: (http://skoczpl/konkurs_umk)

The second contest was aimed at the increase of teachers' and students' awareness concerned with the interrelationship between people and local environment to achieve understanding of sustainable development idea. Because environmental science is interdisciplinary subject, the competition was addressed to teachers of different disciplines: from biology, chemistry and physics to sport and art. The following features of reports were assessed: compatibility with the competition requirements, subject and methodological values, originality (novelty), involvement of students, quality of the report. All together 46 projects from different schools have been evaluated. The highest marks got the projects, which were innovative, inspiring and practical - ready to use in the local environment, but first of all those presenting a deep subject understanding of ecological problems based on science and technology knowledge. Let's quote exemplary titles of the awarded projects: "In quest for civilisation - in harmony with nature", "How to live in accordance with the idea of sustainable development, "Agenda 21 - school aegis RIO + 10", "Ecological Education PLUS", "Youth Nature Patrols", "Clean Odra - school monitoring of water", "Recognition of environmental endangers in village Wójcin", "It will be forest here", "Rational management of water resources", "Water as a source of life", "Abundance of grass species, how to preserve biodiversity of sappy meadows", "Packages are also garbage", "Wastes management", "Auto-recycling".

The most important ideas and values of these projects were highlighted and recommended to other science teachers during the pre-service and in-service teacher training courses. In this paper there is not enough space for presenting some further details concerning the evaluation and examination of our programme.

Nevertheless, we hope that working with teachers in that way we are contributing (at least a little) to the preservation of *our beautiful Nature* for the future generations.

REFERENCES

- Brown et al. (1992). State of the World, New York, London, W.W. Norton & Company
- Berenfeld B., Tinker R. (1995). A Planet in our Hands, Ed. Marx G., Budapest. Etvos University.
- Enger E.D., Smith B.F. (2000). Environmental Science, A study of interrelationships, USA. McGraw-Hill Higher Education Company. <http://www.oei.es/decada/>
- Lucas A. in paper Dillon J. (1996). Environmental Education, Computer in Education, Environmental Studies, Torun. Top Kurier.
- Turlo J., Berndt M., Wichrowska H. (1993). Ecological Aspect of Science Curriculum Development, Jerusalem, Int. Conf. Science Education in Developing Countries.
- Turlo J., Wichrowska H. (1995). A Planet in our Hands. Budapest. ed. Marx.
- Staszal M. (1995). A Planet in our Hands. Budapest. ed. Marx G.
- Reid A., Teamey K., Dillon J. (2002). Traditional ecological knowledge for learning with sustainability in mind, The Trumpeter, vol. 18, 1/2002.
- Reis G., Roth W-M (2007). Environmental education in action. Environmental Education Research, Vol.13, No.3.
- Cotto D.R. E. et al. (2007). Sustainable development, higher education and pedagogy: a study of lecturers' beliefs and attitudes. Environmental Education Research, Vol.13, No.5.
- McNaughton M.,J. (2007) Sustainable development education in Scottish Schools, Environmental Education Research, Vol.13, No.5.
- Turlo J., ed. (1996). Protection and Management, of the Environment, Center for Teachers' Training, pp. 181, Warsaw 1996 (in Polish).
- Turlo, J. ed., 2001, Interdisciplinary science projects, Torun, Top Kurier (in Polish).
- Holbrook J., Rannikmae M., Supplementary Teaching Materials - Promoting Scientific and Technological Literacy, Tartu, Estonia: ICASE.
- Turlo J., Przegiętka K., Służewski, K., Turlo Z., (2004). Invited paper: Propositions of nuclear issue education for teachers and students, Ed. of International Atomic Energy Agency Conference "Nuclear Knowledge Management: Strategies, Information Management and Human Resource Development", Saclay. ed. IAEA-CN-123/04/P6/2005.