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METHODS OF SUCCESSFUL LEARNING IN ENVIRONMENTAL EDUCATION

ÇEVRE EĞiTiMiNDE BAŞARILI ÖĞRENME YÖNTEMLERİ

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ABSTRACT
The article discusses the problems connected with effective learning in environmental education (EE). Educational goals, approaches to teaching, basic organizing ideas and the main constructs of an innovative model of EE are dealt with in the paper. Basic strategies of learning are outlined and dominant methods briefly characterized. Students' activities are organized along a five-component structured model integrating knowledge, values, ethics, skills and evaluation. Criteria for evaluation of educational results are outlined. Effectiveness of teaching methods is assessed and confirmed using statistical methods.

Key words: Successful learning, environmental education, innovative model of EE, innovative methods of learning/teaching, health-environmental competency.

ÖZ
Bu makale, çevre eğitimi yöntemlerinin etkili kullanmada yaşanan problemlerle ilgili bir araştırma programına dayalıdır. Burada sunulan çalışmada ilerici bir çevre eğitimi modelini oluşturan eğitimin amaçları, öğretim yaklaşımları ve temel organize fikirler yer almaktadır. Temel öğrenme stratejileri ana hatlarıyla belirtilmiş ve esas yöntemler kısaca açıklanmıştır. Öğrencilerin aktiviteleri biliş, değerler, etik, beceri geliştirme ve değerlendirme/öz değerlendirmeyi biraraya getiren beş kısımlı bir yapı oluşturmaktadır. Eğitsel sonuçların değerlendirilme esasları ana hatlarıyla belirtilmiştir.

Anahtar Sözcükler: Başarılı öğrenme, çevre eğitimi, ilerici çevre eğitimi modeli, sağlıklı çevresel yetkinlik.

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INTRODUCTION

Preparing students for their future life requires active classrooms and successful learning. Students spend nearly one third of their lives in schools, shaping their personalities, which are very difficult to change in their later lives. Their integration in society later depends very much on their personal qualities and competences, which to a great extend are products of well organized and well accomplished education involving a cozy atmosphere of mutual understanding, collaborative inquiry learning and experience in all school subjects.

Trying to implement this idea we came across several problems: In what ways in a swiftly changing world should the educational process be organized so that the students can learn successfully throughout their lives? What are the psychological, pedagogical and social factors that exert an influence upon successful learning? How should successful learning be evaluated? These questions build up the core of a successful society tomorrow. These challenges motivated us to try and find some solutions.

1. Significance of teaching methods

Successful learning in environmental education (EE) is closely related to methods used by the teacher and the learners. In an age of incessantly growing information the entire educational paradigm changes continuously due to the unceasing social and technological changes (Gang, 1989). Many problems connected with successful teaching are under investigation (see notes): students working in small groups (Carlson, 2003), debating (Christudason, 2003), peer learning (Gwee, 2003), competition and cooperation (Ip, 2003), concept construction (Ip, 2003), meaningful learning (Ip, 2003a), project work (Ip, 2003b), problem solving (Meyer-Hole, 2003), presentations (Toy, 2003), motivation (Lines, 2003), and grading teachers (Monahan, 2000). The teachers` role is to organize, direct, guide, help and support the inquiring cognitive activity of students. The student is at the center of the educational process (Ellis, Sinclair, 1990; Marzano, 1997; Gang, 1989). It is no longer enough for the teacher to know a lot, to be able to explain in a simple and interesting way, and to have personal charisma. He or she should facilitate and direct learning by stimulating students to ask questions, reacting to their answers, helping them accept challenges and disagreements, discuss contradictions, think critically and offer creative solutions. It is very important for the students to overcome their dependence on the teacher by developing their own styles of successful learning and skills for objective and realistic self-evaluation. That will help them to undertake the responsibility for their education and personal development and to avoid putting the blame for their failures on somebody else (Kostova, 1998).

Interest in strategies of learning has been renewed nowadays for several reasons. For example, society gives priority to students and directs strategies of teaching and learning towards the development of his or her autonomy. This fundamental right of the student requires acquisition of cognitive methods and of methods of self-assessment, self-reflection and self-organization (Ellis & Sinclair, 1989).

2. Successful learning

The problem of successful learning is at the center of many contemporary studies; concerned with developing competences (Bandura & Schunk, 1981), observing dimensions of learning (Brown, 1995), developing the seven intelligences (Gardner, 1987), and teaching with the five dimensions of learning (Interactive Didactic, 1998). According to R. Marzano, “five types of thinking, called the five dimensions of learning, are essential to successful learning” (Marzano, 1997). That is why it is essential to distinguish the process of learning from its outcomes and to see the close relationship between them.

Learning as a process means the conscious endeavor of the learner for accomplishing personal educational necessities, interests and aims in correspondence with social requirements for effective adaptation and integration in social life and in line with the present state of science and culture. It involves “the processes of acquiring knowledge and skills through practice, study or information”. Learning by doing is recommended nowadays and is defined as “the process of acquiring understanding, knowledge, skills and attitudes through practical and applied activities” (Glossary, 1983). It is a process of becoming competent.

Learning as an outcome is represented by the expected results, acquired by the learner, which can be a basis for and a means of further learning. “Knowledge changes knowledge”. “Knowledge should be used meaningfully by decision making, problem solving, invention, experimental inquiry, investigation and system analysis (Marzano, 1997). Effective learning is assessed by means of its results measured against the aims.

Education in the modern world is not confined to a certain period of human life but is a lifelong process. It is the “beating heart of the society” (Delors, 1996, p. 20), the bridge between the past, the present and the future and its significance is continuously getting deeper and deeper. J. Delors points out that “people have to go back to learning in order to cope with the new situations arising in their personal and working lives. This necessity is very obvious and is growing stronger and stronger. The only way for its achievement is when everyone learns how to learn (Delors, 1996, p. 21). For that purpose it is necessary to stick to four pillars: “learning to live together, learning to know, learning to act, and learning to be” (Delors, 1996).

For living in the twenty-first century, new personal characteristics are needed – memory, physical abilities, aesthetic feelings, communication skills, the charisma of the leader. Knowledge is dynamic and is continuously passing from one state into another and that is why it should be acquired, renewed and used in life (Delors, 1996).

For successful learning to be possible, students should satisfy certain requirements: a conscious approach to cognitive tasks, studiousness, curiosity, tolerance, self-criticism, realistic attitude, open-mindedness, active learning, and organization (Kostova, 1998). They should develop "powerful habits of mind that enable them to think critically, think creatively, and regulate their behavior" (Marzano, 1997)

There is a difference between cognitive skills and a capacity for self-education. Cognitive skills prepare for the achievement of short-term goals and are initiated by an external factor (National Educational Standards). A capacity for self education requires unified strategy for learning and development of personal plans and aspirations. The student has to rethink his methods of learning continuously, experiment in searching for and acquisition of new methods, while at the same time seek actively objective self-evaluation (Kostova, 1989)

The introduction of educational innovations in the classroom develops students' independence and gives them the capacity to be more self-confident and self-reliable in striving for the acquisition of their own goals and aspirations as well as to be prepared for life-long successful learning.

Successful learning requires a change in attitudes to education both in the teacher and in the learner. Every student makes a contribution to the creative climate in a cozy and stimulating classroom and in taking learning out of the classroom into the open or other learning environments. The teacher is a partner, a facilitator, a leader, a stimulator, a force, a master mind of students' successful learning.

Successful learning requires a new attitude to science, viewing it not as an isolated system of knowledge but as a dynamic structure that interacts incessantly with all other parts of culture.

METHODOLOGY

Theoretical Considerations:

1. Goals of contemporary environmental education

Education is a journey to knowledge, skills and values, to successful realization through gradual and effective personal and social development. The journey is successful when the final destination is known beforehand, when we know where to go and how to reach there. Many scientists have contributed to the development and clarification of goals in EE: Stapp, 1978; Schmieder, 1977; Zverev, 1980; Zahlebnii, 1981; Suravegina, 1986;

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UNESCO, 1987; Hungerford, H. & Volk, T., 1990; Kormondy, 1990; Chiras, 1993; Malcolm, 1992; Smyth, 1998 and others. Based on their work, the goal of environmental education as an essential part of education for sustainable development (ESD), can be regarded as acquisition of health-environment competency (Table 1). Its basis is built up by the unity of knowledge about both the health of humans and the health of the environment.

Table 1: **Meaning of Health-environment Competency**

Components	Contents
Knowledge	A system of facts, concepts, laws, relations, unifying themes (generalizations), hypotheses, theories, prognoses, scientific picture of the world, related to the structure and functions of the Biosphere and to interaction of society with nature.
Skills	Readiness and expertise for activities in studying and protection of nature and for sustaining environmental equilibrium; a system of skills to participate in nature conservation activity.
Values	Control of one's own behavior (self-control) in correspondence with a value system (wrong and right, good and bad, etc.), which accepts responsibility to future generations (ethics), appreciates nature and the Biosphere as all-humanity values (axiology), keeps scientifically sound rules for behavior, demands that from oneself and from others and sticks to the principles of ecologically sustainable development.

The contemporary crisis is anthropo-environmental because the problems in the aims and aspirations of humans, and in the means of their interaction with the environment (the problems in their souls), are the causes of the creation and worsening of environmental problems which in their turn sharpen health problems.

Health-environmental competency is based on knowledge, skills and values for the protection of nature outside and inside us. Human beings are natural products as well; as they come into being and the structures and functions of their bodies are governed by natural laws. This competency gives the learner the ability to see the problems in the noosphere, to find solutions, and to prevent the creation of new problems. It incorporates understanding of the mutual interdependence of humans and nations and the skills for effective interaction and collaboration in the presence of cultural diversity. The value component of this competency is expressed through the attitude to his own person, to other people, and to the environment in all its aspects (Kohlberg, 1973; Knapp, 1981; Gilligan, 1982; Caduto, 1985; Maranto, 1990; Entrich, 1994; Kempton, 1995; Dispoto, 1997; Kostova, 2000)

Health-environmental competency is in close relationship with other basic competences: linguistic, informational, socio-cultural and cognitive. Each of these basic competences has its contribution to the personal and social development of students (Wirth, 1992; Sauve, 2002; Kostova, 2004, Atasoy, 2006) and to the building of a system of relationships towards their own personality, towards other people, and to nature.

2. Approaches to environmental education

Environmental education is concerned with complex systemic objects, having countless internal and external connections, and requires complex studies of their structures and functions. For this reason the interaction of a number of approaches is used in environmental education (Table 2). The concept approach is defined as the "active goal-oriented attitude of a human being to reality, which incorporates his theoretical position (strategy) and his practical activity (tactics)" (Kostova, 1980). An approach is implemented into teaching practice by means of a group of methods.

Table 2: A System of Approaches in EE

School contents	Knowledge	Cognition	Value development
Complex	Intradisciplinary	Explanatory	Deonthological
System analysis	Interdisciplinary	Problem solving	Axiological
Integrative		Heuristic	Prognostical
		Inquiry	

Note: The meaning of every approach as a didactic concept is dealt with by Z. Kostova (2003, p. 152-154)

Nature alone is a hierarchically organized wholesome mega system in which living systems are the most complex, occupying the place between molecular and biosphere levels of organization, and are subjected to the influence of cosmic organization (Vernadskii, 1965; Presman, 1976; Presman, 1997). The system organization of nature is based on two principles – the principle of hierarchy and the principle of emergence (Odum, 1983; Reiss, 1998). Every system of nature has summative properties, made up from the sum total of the properties of its building components as well as some new properties, characteristic only for this particular system. Every successive system incorporates the preceding systems in its entity. All natural systems build up a gigantic entity and in order to understand it, an integration of knowledge from different scientific fields is essential. B. D. Komissarov outlines 9 ecological laws that should be centered in biology around which to integrate other scientific areas (1991, p.71-72). Therefore, a system approach is inevitable in EE and requires integration of school subjects (Table 2, column 1).

It is possible in the educational process to reach intradisciplinary (integration in one school subject, e.g. biology) as well as interdisciplinary (integration between several school subjects, e.g. biology, chemistry, physics, geography) synthesis only when real life problems are dealt with (Table 2, column 2). Global environmental problems are penetrating the whole planet and their study and understanding require the interaction of school subjects and of teachers.

Organization of cognitive activity is subjected to the ultimate aim of developing students' ability to think (Marzano, 1997). This can be achieved by means of different approaches (Table 2, column 3) which help teachers or students to explain concepts, to formulate problems for investigation, and to seek solutions by using insight, guessing, and heuristics to pass through the successive stages of the scientific process in acquiring scientific skills.

Personal development of students is impossible without installing in them environmental values (Kostova, 2000). This implies certain qualities, such as duty and responsibility towards their own being, and towards present and future generations. Nature and health are also values. Students acquire skills to foresee issues arising from any decision about environmental problems or from their own behaviors (Table 2, column 4).

3. Basic constructs of the EE model

For the successful study of the scientific spheres of ecology and nature conservation, an innovative model of environmental education, composed of three constructs – didactic, conceptual and technological - has been developed (Kostova, 2003 and 2004). The didactic construct ensures contemporary educational process in which all achievements of pedagogy and psychology are put into practice. The conceptual construct comprises the ecological and environmental concepts and reveals them from different aspects: cognitive, value, ethical, action and control (feedback and monitoring). All the aspects taken together in their close interaction are essential for developing a student's personality. The third construct views the EE as a process that should be continuously subject to rethinking, critical reexamination and actualization at every step of its implementation in correspondence with the development of environmental situation, ecology and pedagogy (Kostova, 2003). The three constructs of the innovative model of EE proposed by Z. Kostova (2003) taken together provide the possibilities for close interaction of psychology and pedagogy with ecology and conservation on the basis of continuous research and improvement. Through the innovative model of EE, the system of approaches is put into practice.

Experimental design:

4. Research program

The research program is directed at discovering the relationship between learning methods and the effective acquisition of EE goals, i.e. the level of development of health-environmental competency viewed as a unity of knowledge, skills and attitudes towards nature and global environmental problems. The research program is organized by Z. Kostova (2003, 2004, 2007), executed in Bulgaria, and incorporates several basic components, which trace the interdependence between the posed problems, the applied methods, materials and equipment, and the obtained results (Table 3).

Table 3: Research Program

Components	Characteristics
Goal	Building up of a system of innovative methods for successful learning and development of students' health-environmental competency.
Sample	The experimental sample consists of 1550 students from 6th to 11th grade, chosen by chance from different towns in Bulgaria (Appendix). The experiment is longitudinal.
Intervention	Interrelationships between innovative methods in the development of students' health-environmental competency.
Hypothesis	If a system of innovative methods is used in environmental education, which places students at the centre of the educational process, increasing their autonomy, then they will acquire skills for successful learning and for personal and social development.
Successive tasks in the research program	1. Understanding the essence of successful learning. 2. Designing a system of innovative methods for successful learning in EE. 3. Checking the effectiveness of the system of innovative methods. 4. Analysis of the results. 5. Improving the system of methods.
Research methods	Theoretical methods of research: theoretical analysis of information; system analysis of basic ecological concepts and problems of the educational documents; system modeling for choosing and matching of educational methods, brainstorming for generating ideas in order to solve the undertaken problems. Empirical methods of research: observation of students' and teachers' work; experiments in order to assess the effectiveness of the innovative methods of teaching; surveys according to prepared questionnaires for collecting data (information, opinions, evaluation); comparative analysis of tests, workbooks, presentations of students for the assessment of their competences; discussions; interviews with teachers and students; expert assessment of the system of criteria; statistical methods.
Criteria for evaluation	1. Knowledge of the system of ecological and nature conservation concepts. 2. Skills. 3. Attitudes of students to learning.
Stages of experimental work	1. Preparatory: educating teachers, writing textbooks, notebooks, worksheets, tests etc.. 2. Practical performance: actual educational process of teaching students at schools, using the new system of methods. 3. Reflecting: analysis of data, looking for correlation between methods, searching for reliability of results and making conclusions.

5. Teaching/learning strategy

The experiment was organized as pre-post test with several variables, each variable investigating the effect of a certain combination of methods with one predominating. The pre-test is used to see the starting level and the post-test to assess the results.

a) In class lessons the stress was laid on the teacher's presentation (Table 4), giving students a model of scientific investigation by outlining the basic stages and by illustrating them with clear and simplified examples. Students obtained impressions and an understanding about the planning, construction and performance of scientific experiments in order to solve problems in ecology and conservation via the explanation of the teacher. They received a mental picture of scientific methods and equipment, and an understanding of scientific concepts. Using PowerPoint presentations, the teacher acquainted the students with different methods and styles of learning such as constructing intellectual maps of concepts, taking notes, drawing tables, preparing graphs, making conclusions, etc. (Radka Karadjova – Appendix). In spite of the teacher's dominance, we tried to create a learning environment for the students to develop their own learning strategies.

b) Seminars (Table 4, 2) gave priority to students' presentations on the problems studied in such a way that, taken together, they build a complete picture of the topic. Seminars proved to be very suitable for the development of leadership characteristics in students when they were allowed to lead and perform (Svetla Karateneva, Appendix).

c) Expert learning offered educational process giving students nearly full autonomy. They worked in small groups (5 students) as a team. Every student became an expert in a given topic from the contents studied and played the role of teacher in the group, thus performing peer education. In our experiment, students regrouped twice. First, they divided into as many groups as was the number of the studied problems (or subtopics). They investigated the subtopics, discussed them in the group, and after that they rearranged themselves into new groups in such a way that each new group had a specialist (an expert) for each subtopic. Everybody in the group was a teacher to his or her partners and at the same time learned from them. (Lilyana Ilcheva, Appendix)

d) School conferences matched learning with social activity. Each was dedicated to a large topic and required a longer period of time for preparation. Students prepared short scientific presentations and posters, a science fair to show their models, and songs and poems to entertain the audience. This mode of organization ensured the opportunity for them to develop their communication skills and speak fluently in public. (Lilyana Vesselinova, Appendix)

Table 4: Student Centered Education

Organization and teachers	Methods	Learning activities
1. Class lesson R. Karadgova	**Lecture,** making intellectual maps, discussion, visualization, demonstration	Formulating a problem, recall, asking questions, supporting evidence, giving opinion, reflection, critical evaluation, sharing experience, searching for clarity, directed observation, constructing meaning, conceptualizing, intellectual contribution.
2. Seminar – peer education, learning from classmates V. Lozanova V. Uzunova	**Presentations** of students**,** discussion, small group work, homework studies, debating	Analytical listening to classmates' presentations, critical perception, asking questions, giving answers and objective evaluation, acknowledging achievements, participation with own contribution (preparation), on time clarification of all problems, rewarding partnership in learning, respectful and responsible attitude to others' work, conceptualizing the information, constructive communication.
3. Expert learning – peer education, self-directed learning. V. Mirazchiiska L. Ilcheva M. Georgieva Sv. Karateneva	**Scientific experiment,** observation, project work, **presentations**, discussion, evaluation, small group work, jig-saw strategy.	Using a computer, Internet, preparing a bibliography, visiting resource centers, searching, preparing collections, analyzing, evaluating peers, self-evaluation and evaluation from peers and the teacher, integrating knowledge and using it in new situations for solving new problems. Intellectual, emotional and social involvement of students. Interpersonal communication, exchange of ideas, partnership, team work, presentations (posters, PowerPoint), critical thinking and attitude to the results from learning and communicating, critical reflection and self-reflection.
4. School learning conference L. Veselinova D. Vasilev R. Popova	**Project method,** scientific approach, discussion	Investigation, presentation, socialization, awareness of one's own contribution, developing own image, the class and school images, asking questions, giving opinion, presenting a poster, using multimedia, respectful attitude to participants.
5. Laboratory investigation P. Ivanova A. Hristova N. Simeonova	Observation, experiment, discussion, note-taking,	Scientific skills, development of scientific thinking, asking questions, giving opinion, collecting data, constructing supportive evidence, giving answers, partnership, team work, communication, using primary evidence, formulating ideas, creating interest in learning.
6. Ecological set of investigations, small group work Il. Mircheva	**Ecological experiment** (field work), observation, discussion.	Communication and interaction within the group and between groups, making and accepting rules, listening, consensus, respectful attitude to others' contribution, sharing others' success, responsibility, acquiring methods for ecological investigations, data processing, sharing results and opinions, reflection.
7. Excursion D. Bratovanova Sv. Karateneva	**Observation,** data gathering, discussion, data processing	Making and accepting working rules, stating a problem, working out a plan, collecting data, measuring, using worksheets, data processing, taking photographs, offering solutions, accumulating supportive arguments.

8. Practical participation (session) N. Andreeva Ts. Ninova	**Practical work,** fruitful collaboration, communication	Participation in practical nature conservation activities, modeling, digging, sowing, weeds extermination, grass growing, cleaning, caring after ill animals, feeding animals (technical skills), applying theory to solving real practical problems.
9. Role playing L. Dakova R. Delcheva	**Modelling** of a social system, presentation	Use of ICT, dramatization, empathy, playing the role of a teacher, a detective, a statistician, a nature conservationist, an ecologist and others, analysis of ecological policy, searching for ecological problems.
10. Case studies A. Chuturkova V. Bojkova S. Marinova	Analysis, role playing, **brain storming**, **discussion**	Generating ideas for alternative solutions, empathy – “stepping in somebody else’s shoes”, clearing up the situation, anticipating the consequences of each solution, choice of solution.
11. Out of class activities R. Ostreva M. Popinska	**Interview,** observation, **experiment**, modelling, discussion	Collecting information, interviews with specialists, ecological investigations in the open, development of projects, making collections, constructing models, apparatus, preparing drawings, taking photographs, multimedia products, albums, surfing the Internet, studying habitats, historical monuments, biodiversity, organizing conservation campaigns, participating in environmental societies, clubs and holidays.
12. Out of school activities L. Vesselinova S. Kosteva	**Team work,** presentations, discussions	Solving problems, making projects, preparing posters, participating in nature conservation activities, making contacts, communicating, writing a vocabulary, encyclopedia of ecology, preparing for contests and Olympiads.

e) The discussed modes of organization differ with respect to the dominance of teaching methods (Table 4). Bearing in mind the source of information – words, images and actions, methods can be classified into three groups – verbal, visual and practical. This is one of the oldest classifications of methods, proposed by N. Versilin and Korsunska (1983). Using the verbal methods, students receive information from teacher’s speech – lecture, retelling, explanation, presentation - as well as from available books and articles, or the Internet. Visual methods include observation of drawings, films, experiments, tables, graphs, models and other teachers` or students` demonstrations as well as observations of natural phenomena. Practical methods are mainly represented by manual work involved in experiments, modeling, sowing, digging, caring of plants and animals, etc. Combinations of the three methods unite the work of all receptors – hearing, vision, taste, touch, smell, and proprioreceptors and make the reception of information multi-sensory. Multimedia combine words, vision and action and the received information is richer in content. Verbal methods are extended by the use of hypertext in computer-based education. Multimedia offers a new learning environment which is of different quality. Using it, students increase their activity and freedom when participating in the educational process (ISTE, 2000). ICT challenge them to use different programs for qualitative and quantitative analysis of the obtained experimental results and for presenting it in a clearer and more eye-catching way and thus provoking intellectual tension. Using the project method, the verbal, visual and practical methods combine, exerting their influence on thoughts, emotions and motor actions.

The student is the leading factor of his own education and development, having personal goals and plans as well as achieving the goals in the National educational standards. Because of that, innovative methods help the student understand his own capacities and choose a system of learning which is most rewarding. Each one of the cognitive activities stimulates the development of the basic educational competences (Table 5).

Table 5: Personal Characteristics Connected to Basic Competences

Competences	Personal characteristics
Linguistic	Communicating ideas, writing clearly and precisely, speaking fluently, formal and informal communication, fast and analytical reading, preparing a bibliography, writing essays, bulletins, articles, brochures, etc.
Informational	Searching, analyzing and organizing information, use of ICT (working with software products, Internet, Web, processing information, taking and organizing knowledge).
Socio-cultural	Working with other people in a team, partnership, tolerance, understanding other people, flexible thinking, stimulating mood, kind interrelations, precision, responsibility in work, communicating with teachers and schoolmates, coping successfully with text-books, role playing, discussion, reaching consensus in making decisions.
Cognitive	Scientific knowledge concerning the problem, working out a strategy for solving the problem, making a decision in a conflict situation, choosing from alternative solutions, constructing meaning, rationalizing experience, studying cases, constructing support, popularizing the achieved results in the created products from learning.
Health-ecological	Thinking out the reasons, the symptoms, prophylaxis and treatment of diseases and of environmental problems. Health and nature as values, responsibility to health and the state of the environment. Healthy way of life.

That can be achieved if the student tries to solve learning tasks which integrate the information and learning methods from different school subjects (Kostova, 1980). Besides that, learning tasks for students have to reflect all the components of the conceptual construct and in that way to facilitate the conceptualization of knowledge (Table 6).

Table 6: Components of Conceptual Construct of Innovational Model

Component	Activities and personal qualities
Cognitive	Scientific, ecological and nature conservation knowledge and methods of scientific research. Solution of real life problems, project development, making experiments and observations, curiosity, open-mindedness, construction of support, application of knowledge and experience in new situations.
Value	Presentation and evaluation (self-respect, self-control, unguided discovery, realism, life-long education, joyful mood).
Ethical	Presentation and evaluation, case studying and solving (mutual respect, listening to others, trust in classmates, responsibility to oneself and to others).
Action	Planning of activity, presentation, sharing knowledge, experience, opinion, collaboration, stability, defining the lack of information, application of knowledge, participation in cleaning, grass growing, tree-planting, taking care of animals and plants, etc.
Monitoring	Evaluation, self-evaluation, objectivity, punctuality, self-respect, sound scientific knowledge, consensus, self-reflection, overcoming examination stress, responsibility for one's own development and behavior, regular studying and preparation, stability in learning.

For example, the task presented as a problem was: “Should Japan receive permission to whale for trade purposes?” (ISTE). This may be discussed from different aspects in correspondence with the five components of the conceptual construct of the innovative model of EE by organizing a role play featuring an “International commission for whale preservation” under the auspices of the UN (Fig. 1). Students played the roles of marine ecologist, economist, statistician and nature conservationist.

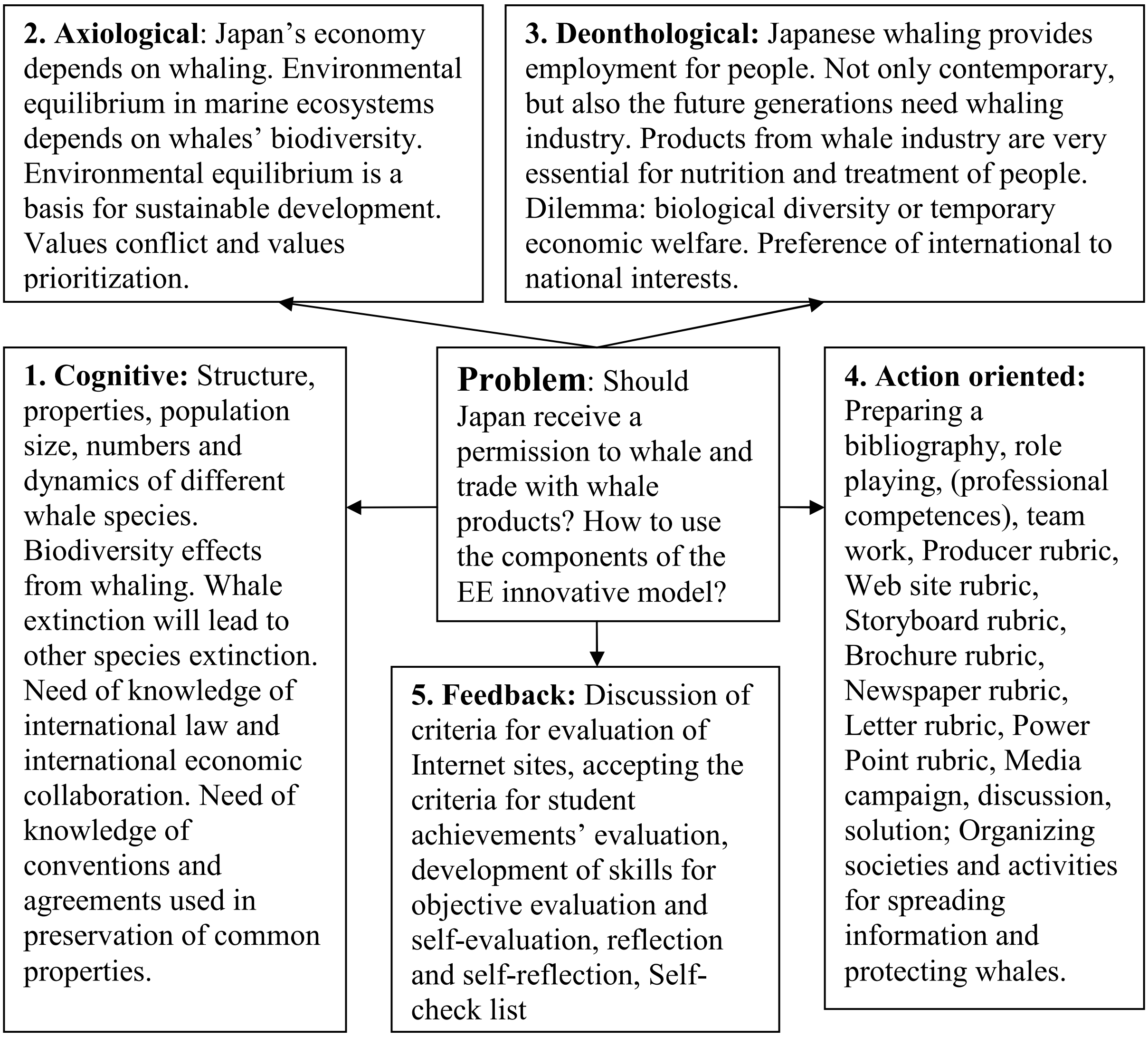

Figure 1: Application of the Innovational Model of EE to Solve a Particular Problem (Adapted by Z. Kostova as a Project of Microsoft Bulgaria within the Initiative "Partners in Cognition").

Cognitive learning activity for solving the problem of whaling was concerned with searching for information about whale population size and numbers of the different species (marine ecologist and statistician), way of life, method of communication, specific behavior of each species (courtship, birth-rate, death-rate, etc.) (marine ecologist), state of marine environment, factors influencing lives of whales (environmentalist), dependence of Japanese economy on whaling (economist) and so on. Teachers prepared a list of checked and recommended Internet sites to look for information and offered it to the students to study and analyze, using statistical methods and debating in the small groups, thinking critically and making a decision for solving the problem. In some cases the problem was posed by the teacher and in others it was formulated by the students, which stimulated their "problem vision" (Kostova, 1980).

Value development activity requires value prioritization in order to solve the problem. Students have to choose between long-term and short-term values. Which should they prefer – sustaining the ecological equilibrium in the marine ecosystem or reviving the Japanese whaling economy? Sustaining whaling populations in equilibrium with the external environment is essential for keeping the marine ecosystems in balance, from which the economy may benefit later.

Ethical (moral) development activity is directed towards the responsibilities of everybody to protect the environment from deteriorating human actions. The problem of waling is ethical, aesthetical and humanistic because every human being, present and future, has the right to a high quality environment. We cannot use up all our resources as future generations, that come to life as a result of our wishes, will also need them. It is immoral to give birth to people but leave them without a proper environment. Besides, humanity should continue far ahead into the future – preservation of nature means preservation of human life as well. The extinction of whales will bring many unforeseeable outcomes including extinction of other species. Rules and rights mean responsibility. Behavioral rules include constructive collaboration as well.

Skills development activity is extremely important. Students prepared a bibliography on the problem to be studied, made tables and graphs on population dynamics, a photo essay on whales' biodiversity, constructed maps about whales' habitats, visualized the significance of the Japanese economy in whaling, proposed alternative economic strategies, and preserved the collected information on CD. Every working team prepared a PowerPoint presentation, then the groups debated their solutions, refined them, constructed meanings to the concepts and reached conclusions by consensus.

The obtained results helped students arrive at meaningful decisions, which ensured sustainable use of resources. This was the way to achieve competence to monitor the state of the environment. Students constructed arguments to support their decisions. The last stage was the pedagogical monitoring. Students assessed each other, everybody assessed himself, and the teacher assessed everybody. Each group was also assessed by the teacher. Students received marks for their work in the group. They analyzed the marks from the teacher and from classmates, compared them with their self-evaluation marks and developed skills for objective self-evaluation. The marks received had to be supported by arguments. In order to put their decisions into practice, they organized a campaign for whale preservation in collaboration with NGO's. At the last stage, when presenting their findings students invited their parents to attend the conferences and presentations and to enjoy their children's intellectual growing up. The school thus solidified its social image.

The examples here give some impression about the teaching and learning strategies in the experimental variables. However, it is not possible or practicable to describe all the details in each variable.

6. Criteria and methods of evaluation

The effects of the teaching and learning methods were evaluated in the following way:

Students' achievements were assessed using Bloom's taxonomy of educational objectives, which gave information about the development of their thinking abilities. The first three levels (knowledge, understanding and application) we regard as characteristics of empirical thinking and the next three (analysis, synthesis and evaluation) – as characteristics of theoretical thinking. In order to assess the achievements of students, we used written multiple choice tests validated beforehand. The psychometric characteristics were studied and the following characteristics determined: validity, reliability, item difficulty, distracter analysis and discriminative force. The validity of tests used in the investigation ranges from 0.75 to 0.95, and reliability from 0.76 to 0.99.

Development of specific skills and attitudes was assessed by means of questionnaires and diagnostic observations using performance based assessment. During the experiment, practical and intellectual skills were assessed, though it was very difficult to distinguish clearly between the two. Attitudes were assessed using statements that require 5-point Likert Type Scale: totally agree, agree, not very sure, disagree and totally disagree. The tests for assessing knowledge, the questionnaire for assessing attitudes, and the check-lists for assessing skills were developed by Z.Kostova (2004). It is not possible to show them here due to lack of space.

Correlations between knowledge, skills and attitudes were calculated using Pirson-Brave's correlation coefficient. Efficiency of teaching and learning methods was calculated using Student t-criterion (Claus, G. & H. Ebner, 1971).

RESULTS AND INTERPRETATIONS

Successful learning in environmental education is assessed by means of its global aim – development of health-environmental competency.

1. Assessing students' knowledge and skills

A Five point scale for assessing students' achievements was used. In Bulgarian practice, quantitative assessment is represented by marks from 2 to 6. A mark of 2 means failure, 3 is a pass and means satisfactory, 4 means good achievement, 5 means very good achievement, and a mark of 6 means excellent achievement. Each student received a mark for his or her performance on each task. Then the average for each task was calculated.

According to this scale, students showed the highest performance at the first level – knowledge (recall of information) (Table 7, Fig. 2). At the next levels their achievements became lower but still stayed above good (4), which means that the methods of teaching and learning we used proved to be successful.

Table 7: Average Value of Students` Achievements According to Bloom's Taxonomy

Bloom`s Taxonomy	6. grade	7. grade	8. grade	9. grade	10. grade	11. grade	Average
I. Knowledge	4.89	4.86	4.89	4.66	4.99	4.86	4.85
II. Understanding	4.95	4.74	4.58	4.49	4.86	4.81	4.73
III. Application	4.8	4.76	4.48	4.62	4.78	4.71	4.69
IV. Analysis	4.03	4.87	4.32	4.39	4.73	4.64	4.49
V. Synthesis	4.32	4.58	4.11	4.27	4.63	4.59	4.41
VI. Evaluation	4.48	4.4	3.7	4.09	4.59	4.42	4.28
Average	4.57	4.7	4.34	4.42	4.76	4.67	4.57

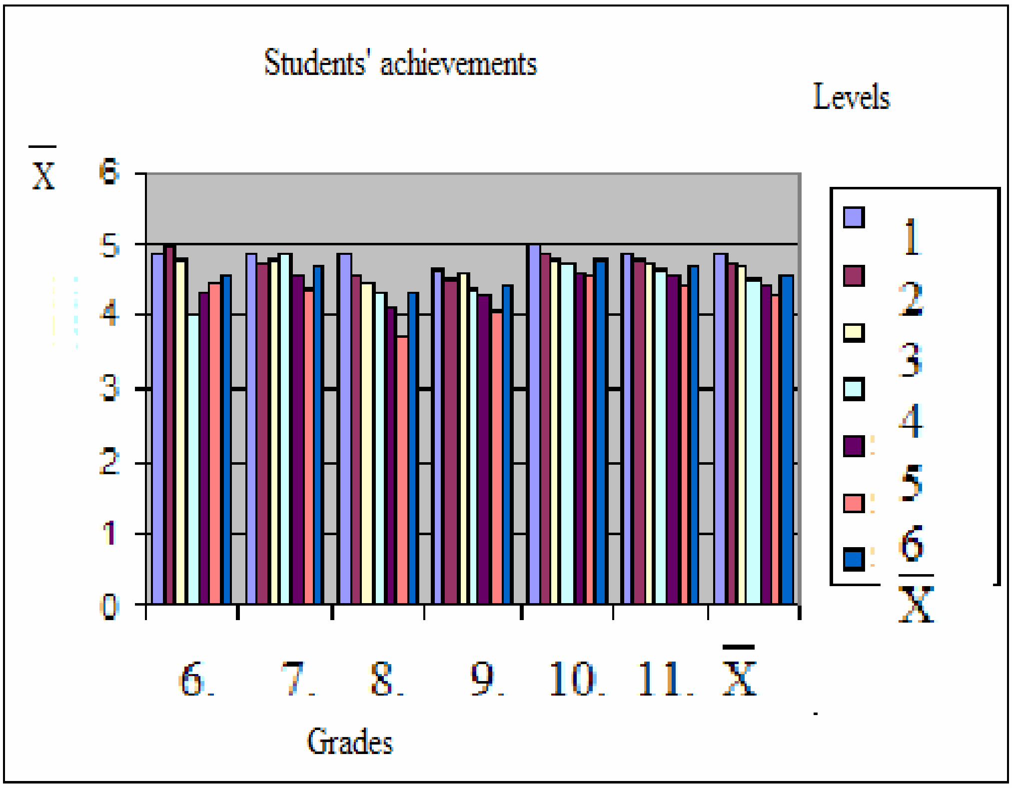

Figure 2: Graphical Presentation of Students' Achievements According to Bloom's Levels

The best results were obtained from the tenth grade students in high school, which was not surprising. The school syllabus in biology for the 9th grade is dedicated to studying the Biosphere for nearly half a school year. In the 10th grade ecological knowledge is re-examined from the point of view of evolutionary theory. The syllabus of the 7th grade includes a chapter on ecosystems and biomes in its core. In this way, ecological and environmental knowledge from 5th to 7th grade is summarized at the end of 7th grade. In the 10th grade there is a second generalization on a higher theoretical level. This explains the better results together with the applied methods. The syllabus gives the opportunity to study ecology and to apply new methods.

2. Assessing students` skills

Skills were assessed using the same scale from 2 to 6 and marking the performance of students accordingly. In the course of the experiment, we investigated 33 skills, grouped into practical and intellectual. Practical skills are assessed according to criteria agreed-upon beforehand. The results are shown on Table 8, Fig, 3.

Table 8: Students' Achievements of Practical Skills

A. Development of practical skills – kinds of assessed skills											
Kinds	1	2	3	4	5	6	7	8	9	10	**Total mean score**
Mean values	4.15	4.9 4.43 5.65	4.28 4.6	4.5 5.23	4.9 4.42	5.58	4.35	4.29 4.68 4.81	4.92	4.99	
Total	4.15	4.99	4.44	4.86	4.66	5.58	4.35	4.59	4.92	4.99	4.75

A. Assessed action skills: 1. Description of birds' habitats; 2. Bird species identification, bird habitat identification, classifying birds and other animals; 3. Use and construction of intellectual maps; 4. Model construction; 5. Application of knowledge in planning and research; 6. Poster presentations; 7. Choice of activity corresponding to the task; 8. Description of layers in a forest community, Constructing food chains, food webs and food pyramids, schematic presentation of cycles of matter and flow of energy; 9. Care of flowers, other plants, animals, cleaning, making a botanical garden in the school yard; 10. Table preparation and graph construction.

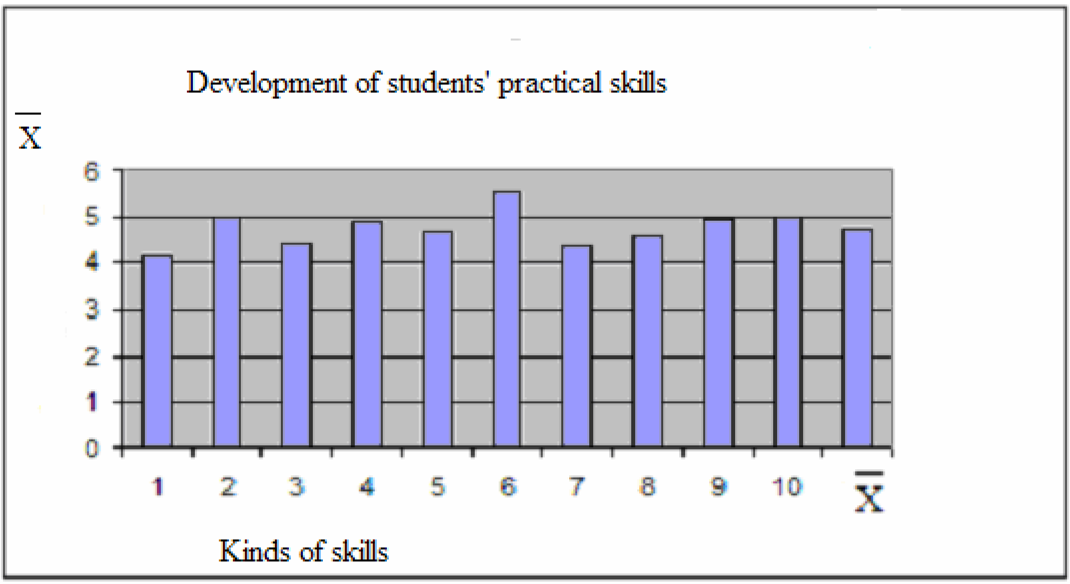

Figure 3: Graphical Presentation of Students' Practical Skills Achievements

The highest achievements were obtained by involving students in autonomic studies. The results of their studies they presented on posters or PowerPoint presentations. These activities attracted them to a new way of learning – solving cognitive problems by carrying out experiments, obtaining first-hand evidence and interpreting data. Most of all, the multiple attractive ways to visualize the studies fascinated them. They adored the possibility of showing their intellectual capacity and dexterity.

Intellectual skills were studied in many different tasks (Table 9, Fig. 4). The highest score students obtained was on studying and solving cases and generating ideas using brainstorming.

Table 9: Students' Achievements of Intellectual Skills (Mean values)

1	2	3	4	5	6	7	Total mean score
4.88	4.9	5.42	5	4.84	5.08	4.49	
4.24		4.8	4.87		4.46		
5.12			5.1				
4.11			5.15				
4.43							
4.55	4.9	5.11	5.03	4.84	4.77	4.49	4.81

B. Assessed intellectual skills: 1. Independent taking of decisions and constructing support, giving an opinion and providing arguments, constructing evidence for practical application of knowledge, illustrating answers with examples; 2. Converting text to tables and vice versa; 3. Solving cases and generating ideas; 4. Formulating problems, offering hypotheses, constructing experiments, analyzing results; 5. Discovering cause-effect relationships; 6. Evaluating the organism-environment relationship; 7. Anticipating consequences of human activities.

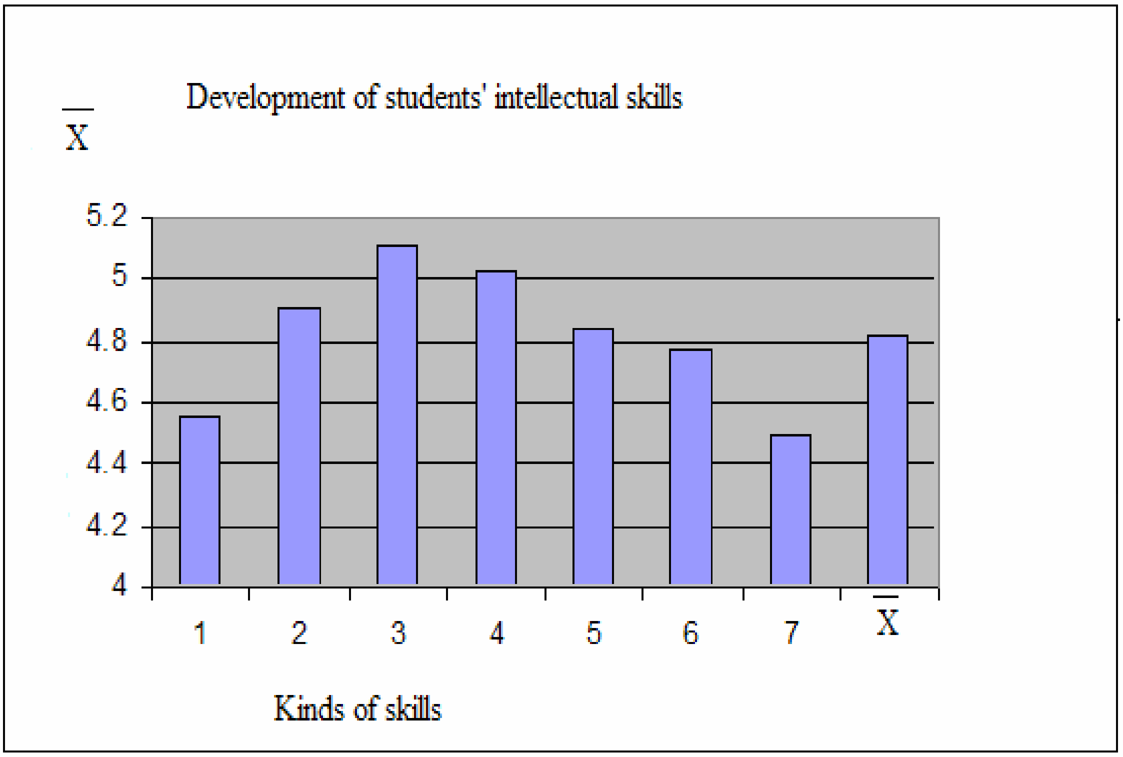

Figure 4: Graphical Presentation of Students' Intellectual Skills Achievements

The score for intellectual skills (4.81) is a little higher than the score for practical skills (4.75), but the difference is not significant (t-test) This is understandable if we take into consideration that in the process of teaching a greater attention was given to tasks requiring intellectual skills. This is not justifiable as in real life practical and intellectual skills are very closely related and a good theory is the best practice.

3. Interdependence between knowledge, skills and attitudes

The correlation among knowledge, skills and attitudes scores were worked out using the coefficient of Pirson-Brave (Claus, G. & H. Ebner, 1971), (Table 10, Fig. 5).

Table 10: Interrelationships between Knowledge, Skills and Attitudes

Correlation coefficient between knowledge, skills and attitudes	Significance	r
1. Knowledge : attitudes	Acceptable	0.57
2. Knowledge : behavior	Uncertain	0.38
3. Attitudes : real behavior	Acceptable	0.72
4. Knowledge : independent taking of decisions	Acceptable	0.6
5. Knowledge : self-evaluation	Acceptable	0.67
6. Knowledge : competences	Uncertain	0.4
7. Empirical knowledge : theoretical knowledge	Uncertain	0.31
8. Skills for intellectual map construction : concepts	High	0.91

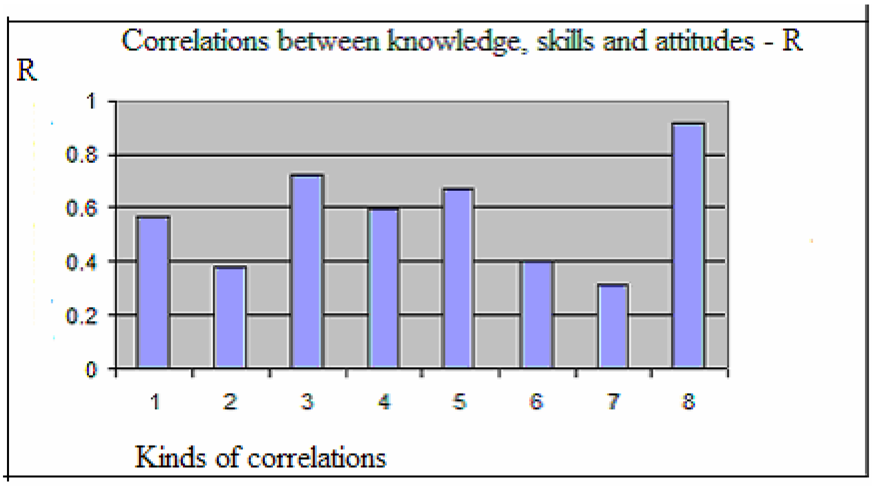

Figure 5: Correlations between Knowledge, Skills and Attitudes

The highest correlation was found between the ability of students to construct intellectual maps and their ability to conceptualize knowledge (r = 0.90) (Table 10, line 8). This proved to be a very productive method as it allowed students to see the relations between concepts and to integrate them in a system with hierarchical structure. Intellectual maps have heuristic property as they make it easier for students to discover new connections between concepts and to build a conceptual network.

Correlation between attitudes and the real behavior of students in nature was high (r = 0.72), (Table 10, line 3). A system of positive attitudes builds the values relationships towards nature, students' ecological consciousness, which in its turn regulates their behavior: r = 0.60, (Table 10, line 4) and the ways they interact with natural objects and phenomena: r = 0.57 (Table 10, line 1). Attitudes without well-organized educational process, providing planned activities in which real-life situations were transformed into pedagogical situations for students to conceptualize, could not give rise to the development of skills and values systems, nor to nature-friendly behavior: r =

0.38 (Table 10, line 2). The higher the conceptualization of knowledge was, the stronger their abilities toward self-evaluation were: r = 0.67 (Table 10, line 5). Pedagogical situations for the development of these skills were also necessary as they were built up with great difficulty and perseverance.

Our studies showed that a very small number of students could self-evaluate realistically. Most of them either overestimated or underestimated themselves according to the state of their self-esteem and self-confidence. The correlation between knowledge and competences is not high: r = 0.40 (Table 10, line 6). The practical application of the five components of the conceptual construct (innovative EE model) contributed to development of competences

The relationship between empirical (recall, understanding and application) and theoretical (analysis, synthesis and evaluation) knowledge (r = 0.31) also needs explanation. We expected higher correlation because in the secondary school, the inductive approach predominated. In our experiment, we introduced suitable theoretical knowledge from ecology and nature conservation earlier in the curricula from fifth grade onwards and in the interpretation of empirical data from students' investigations we tried to reach meaningful theoretical conclusions. The results showed that theoretical knowledge was difficult to understand. The reason for these results might be the academic language of textbooks.

The significance of the obtained results was determined using the following scale: above 0.75 high significance; above 0.50 acceptable significance; below 0.50 uncertain significance (Bennett, 1984).

4. Comparative effectiveness of the different methods

Using Student t-criterion (Claus, G. & H. Ebner, 1971, p. 175), the significance of the difference between the methods of teaching and learning used in the experiment was calculated (Table 11, fig 1). All the results in the table are significant as they are higher than the value of t-criterion for comparison, which is 1.96.

Table 11: Comparative Effectiveness of Methods (t for comparison = 1.96)

Comparisons	t - criterion
1. Application of the whole model of EE versus parts of it	4.79
2. Making models versus use of ready-made models	4.75
3. Expert learning versus teachers' explanation	4.94
4. Observation and experiments versus lecture	3.76
5. Scientific approach versus lecture	4.19
6. Making models versus lecture with demonstration of models	5.55
7. Brain storming and discussion versus lecture	5.31
8. Studying cases and role playing versus lecture	17.3
9. Studying cases versus teacher's explanation and demonstration	6.85
10. Studying cases versus lecture	9.82

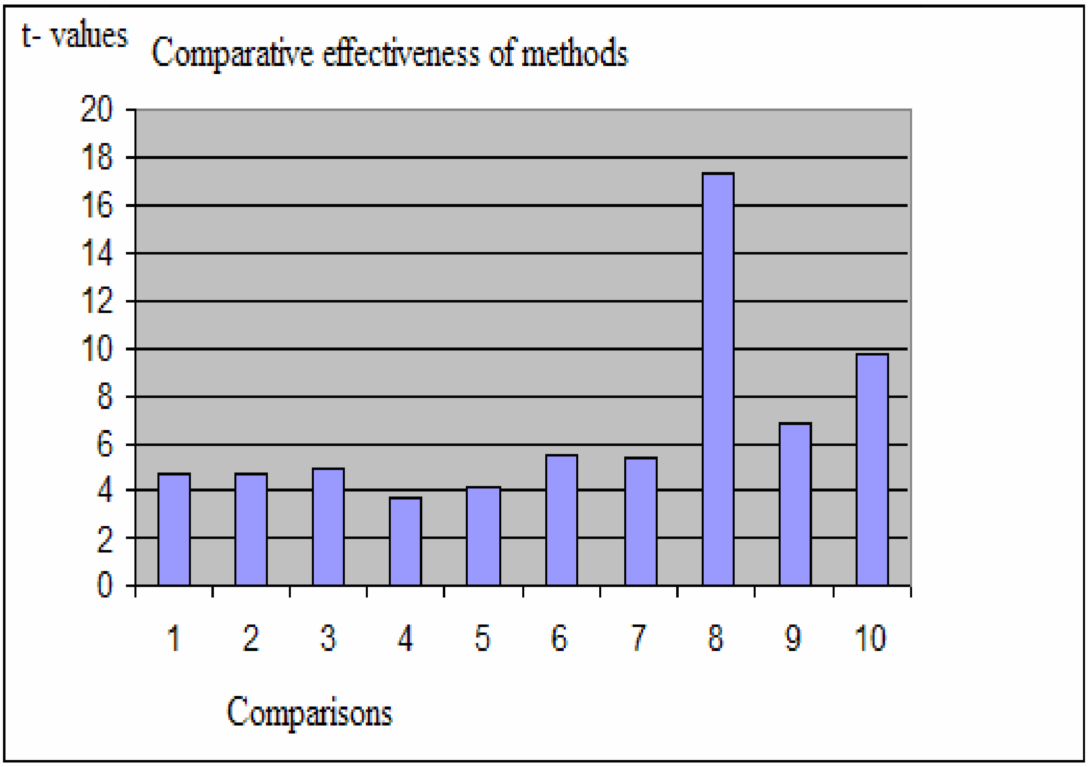

Figure 6: Comparative Effectiveness of Methods

The obtained results for t-criterion were compared with t-criterion from a table (Claus, G. & H. Ebner, 1971). The threshold for significance was 1.96 (α - 5 % of error). Any value of t-criterion above 1.96 shows significance of the results. Full application of the conceptual construct of EE gave better results than partial application [t = 4.79]. Analysis of environmental problems, represented by means of pedagogical situations for conceptualization, from five aspects (cognitive, value, ethical, action-oriented and monitoring) integrates knowledge, feelings and activities from the point of view of environmental consciousness.

Modeling (creative construction of models by students) gave better results than the use of ready-made models t = 4.75 (Table 11 line 2). The same result was obtained when construction of models was compared with the demonstration of models by the teacher t = 5.55 (Table 11 line 6). Students were absorbed by their own work as they were allowed to choose the material and the type of model to use. They were obliged to construct a scientifically correct model and be able to explain it.

Expert learning, when students were in the position of teacher, was more effective than learning from the explanation of the teacher t = 4.94 (Table 11 line 3). Students searched and learned information on a given topic and then taught their classmates. In the working team, each student was a learner in one topic and a teacher in another. Experiments and observations were much more effective than teachers' lectures, because they brought the satisfaction (assessed by observation) from obtaining first-hand evidence by students. It was fascinating for learners to find out how things work, to get results and to compare them with the results from scientific papers. Using the scientific approach, students were placed in the role of a scientist and passed through the full stages of a scientific investigation (defining a problem, proposal of a hypothesis, working out an experiment, constructing and analyzing data and making inferences) $t = 4.19$ (Table 11 line 5). Generating ideas using brainstorming and discussions was also more effective than learning from lectures $t = 5.31$ (Table 11 line 7). Lecturing did not hold the attention of students very long. That is why we had to reorganize lectures in the following way. Students were given worksheets with tasks to accomplish after listening very carefully to a portion of the classroom lecture. After that there was a discussion and explanation from the teacher, and the lecture continued with the next portion, the next task, the next discussion and so on. This increased both students' learning and their achievements.

The case studies were also organized in a new way. Students were given cases represented as cartoons with unfilled bubbles. They had to make a story, fill in the blanks generating ideas, choose a character and play the role. After that students had to discuss the information learned, their feelings, impressions and activities. Using such teaching was much more effective than lectures, especially concerning health and environmental topics $t = 17.\ 3$ (Table 11 line 8). Results were not so high if case studies were not accompanied by generating ideas and role playing $t = 6.85$ (Table 11 line 9), and the teacher tried to explain the situations using illustrations and photos. These results coincide with the results on Table 9, fig. 4. Using the table we can make some inferences about the effectiveness of the explanation-illustration approach when students obtain knowledge from the teacher's speech. Explanation accompanied by visualization was more effective than mere speech, no matter how beautifully worded $t = 6.85$ and $t = 9.82$ (Table 11 lines 9 and 10).

CONCLUSIONS

1. Theoretical studies proved that methods of successful learning have been studied, developed and tried out by many scientists and teachers. For the success of the methods, theoretical clarification of aims is of priority, including good understanding of health-environment competency.

2. The preliminary preparations for the experiment were very important, not only for the planned aims and expected results, but for the further development of the theory and practice of EE and for the benefit of child education. The innovative model gave the theoretical base and the leading solutions for organizing a well structured experimental education.

3. The experiment was broadly planned including many organizational forms and methods carried out by the teachers involved. Lectures, expert learning, conferences, laboratory experiments, field studies, and excursions were organized. In all of them the inquiry work of students predominated.

3. The results from the experiment enlighten the hierarchy of methods for environmental teaching. The highest achievements students obtained were by studying problems and preparing presentations, followed by ecological observations and working in the field, making tables and graphs, caring for plants and animals, and preparing models.

4. Case studies, carrying out ecological investigations, converting data from texts into tables and vice versa, and discovering cause-effect relationships all developed the thinking abilities of students.

5. Most effective proved to be case studies, when students analyzed them by playing roles, feeling empathy for the characters they played and trying to find solutions for the problems posed. Less effective were cases analyzed by the teacher. They were followed by modeling, brain storming and discussions.

6. Observations of the experiment proved that the teaching methods studied helped in integrating knowledge from different subjects around environmental problems and in developing students` and teachers` collaboration.

7. Many problems were discovered which required further studies. Application of each method should be evaluated under different learning environments and the best structure for each method needs to be worked out.

8. Lots of time was necessary for teacher preparation in order to be able to perform experimental studies and to answer the requirements of highly qualified teaching.

9. The syllabus and the textbooks were so burdened with information that it was very difficult to find time for innovative methods of teaching and for children to learn how to learn. Besides, students could not afford or were not motivated to buy the workbooks that offered practical application of new methods for effective learning. The national standards, though good because they set the threshold for passing from grade to grade, were a hindrance for excellent students as they did not stimulate them to reach higher prospects.

10. Social tension and psychological fatigue from lack of aspirations and good future prospects also were barriers to successful learning.

11. The use of innovative methods for effective learning requires adequate teachers' qualification, adequate competences, and a determination to achieve collaboration between teachers, between students, between students and teachers, and also involving parents as well. Parents should not stand aside when their children are growing up, not only physically but intellectually as well.

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APPENDIX: Applicacion

Table 12: Schools and Teachers Involved in the Experimental Teaching (2000 – 2006)

How many students and teachers were invited from each of the schools?

Towns	Teachers	Grades	Number of students
1. Sofia	Radka Karadjova	6th	50
2. Sofia	Lidia Dakova	6th	15
3. Sliven	Rositsa Delcheva	6th	50
4. Kostenets	Lilyana Ilcheva	7th	38
5. Burgas	Milena Popinska	7th	50
6. Burgas	Atanaska Tchuturkova	7th	80
7. Sofia	Radka Ostreva	8th	80
8. Pleven	Nikolina Andreeva	8th	50
9. Sofia	Vessela Bojkova	8th	54
10. Pernik	Donka Bratovanova	8th	54
11. Blagoevgrad	Illonka Mirtcheva	8th	60
12. Sofia	Nevena Simeonova	8th	51
13. Vidin	Sashka Marinova	9th	90
14. Sofia	Milena Georgieva	9th	80
15. Pleven	Vessela Mirazchiiska	9th	19
16. Samokov	Svetla Karateneva	9th	170
17. Kustendil	Sonya Kosteva	9th	84
18. Pernik	Aglaya Hristova	9th	78
19. Sofia	Petya Ivanova	9th	80
20. Sofia	Vassilka Usunova	10th	78
21. Sofia	Tsvetanka Ninova	10th	60
22. Sofia	Velitchka Lozanova	10th	44
23. Sofia	Lilyana Vesselinova	10th	59
24. Sofia	Rossitsa Popova	10th	40
25. Shumen	Dragomir Vassilev	10th	36