Methods of Successful Learning in Environmental Education

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***Abstract*—The article is based on a research program involving the problems of effective use of methods in Environmental education (EE). Interpretation is given to educational goals, approaches to teaching, basic organizing ideas and the main constructs of an innovative model of EE. Basic strategies of learning are outlined and dominant methods briefly characterized. Students' activities are structured along a five-component structure integrating cognition, values, ethics, skill development and evaluation/self-evaluation. Criteria for evaluation of educational results are outlined.**

***Keywords*— effectiveness of learning strategies, environmental education, health-environmental competency, innovative methods of learning/teaching, innovative model of EE, successful learning.**

I. Introduction

I.I. Significance of the methods of successful learning in environmental education (EE)

In our information age the entire educational paradigm changes continuously due to the unceasing social and technological changes. The teacher's dominance is giving way to the student as a centre of the educational process. 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, by reacting to their answers, helping them accept challenges and disagreements, discuss contradictions, think critically and offer creative solutions (Monahan, 2000). 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. As a result of that they will be able to undertake the responsibility for their education and personal development and will not put the blame for their failures on somebody else [1].

The interest in the strategies of learning has been renewed nowadays for several reasons: society puts priority to the respect of the student and directs the strategies of teaching and learning to the development of his or her autonomy [2]. This fundamental right of the student requires acquisition of cognitive methods, of methods of self-assessment, self-reflection and self-organization [3].

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I.II. Modern understanding of successful learning

The problem of successful learning is in the center of many contemporary studies. That is why it is very essential to distinguish between the process of learning and the outcomes of it and to see the close relationship between them.

Learning as a process means conscious endeavor of the learner for accomplishing personal educational necessities, interests and aims in correspondence with the social requirements for effective adaptation and integration in social life and in line with the present state of science and culture. It is a process of becoming competent.

Learning as an outcome is represented by the expected results, by the achievements of the learner, which can be a basis for further learning. Learning as a process and its results, the achievements are very closely related. The effective learning is assessed by means of its results measured against the aims and the results are a means of further learning.

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". It is 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 it is growing stronger and stronger. The only way for its achievement is when everyone learns how to learn [4]. For that purpose it is necessary to stick to four principles: "to learn how to live together, to learn to know, to learn to act, to learn to be" [4].

For living in the twenty first century new personal characteristics are needed – memory, physical abilities, aesthetic feelings, communication skills, 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 [4].

For successful learning to be possible students should obey certain requirements: conscious approach to cognitive tasks, studiousness, curiosity, tolerance, self-criticism, realistic attitude, open-mindedness, active learning, organization etc. [1].

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 (State Educational Standards for example). 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 as well as experiment in searching for and acquisition of new methods while at the same time act actively to objective self-evaluation [1].

II. PHILOSOPHY OF EDUCATIONAL PROCESS IN ECOLOGY AND NATURE CONSERVATION

II.I. Goals of contemporary environmental education

The first step in trying to find an answer to the posed questions is to define the long-term goals of a successful environmentally directed educational process. Education is a journey to knowledge, skills and values, to successful realization through gradual, step by step 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.

The goal of environmental education as an essential part of education for sustainable development is acquisition of health-environmental competency (table 1). Its basis is built up by the unity of health and environmental knowledge. The contemporary crisis is anthropo-environmental [5] 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 for generation and sharpening of environmental problems which in their turn sharpen the health problems.

Health-environmental competency is based on knowledge, skills and values for protection of nature outside and inside us. This competency gives the learner the ability to see the problems in the noosphere, to find solutions and to prevent from the appearance of new problems. It incorporates the understanding of 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 [6].

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 the students [7] and to the building of a system of relationships towards their own personality, towards other people and to nature.

II.II. Approaches to environmental education

Environmental education is concerned with system objects, which are complex, having countless internal and external connections and require complex studies of their structures and functions. For this reason a system of approaches is used in environmental education (table 2). Nature alone is a hierarchically organized wholesome mega system in which the living systems are most complex, occupy the place between molecular and biosphere levels of organization and are subjected to the influence of cosmic organization. The system organization of nature is based on two principles – the principle of hierarchy and the principle of emergence. 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 very essential. That is why in environmental education subjects integration is very important [8].

It is highly possible in the educational process to reach intradisciplinary as well as interdisciplinary synthesis only when real life problems are dealt with. Global environmental problems are wholesome penetrating the whole planet and their studying and understanding require interaction of school subjects and of teachers [5].

Organization of cognitive activity is subjected to the ultimate aim of developing students' ability to think [5]. This can be achieved by means of different approaches, which help teachers or students to explain concepts, to formulate problems for investigation, to seek solutions, using insight, guessing, heuristics and pass through the successive stages of the scientific process acquiring scientific skills.

Personal development of students is impossible without installing in them environmental values [5]. They imply certain qualities such as duty and responsibility towards their own being, towards present and future generations. Nature and health are also values. Students acquire skills to foresee issues from any decision about the environmental problems or from their own behavior.

II.III. Basic organizing ideas in experimental environmental education

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

Successful learning requires 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.

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

II. IV. Basic constructs of the EE model

Successful studying of the scientific spheres ecology and nature conservation requires an innovative model of environmental education, composed of three constructs –

didactic, conceptual and technological. 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 student's personality. The third construct views the environmental education 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. The three constructs 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 them the system of approaches is put into practice.

II.V. Research program

The research program is directed at discovering the relationships between the methods of learning 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 incorporates several basic components which trace the interdependence between the posed problems, the applied methods, materials and equipment and the obtained results (table 3). The experimental teaching involved 25 teachers and 1550 students from 25 schools from 2000 to 2006 (table 12).

III. Basic strategies of learning

III. I. Modes of organization and activities

In class lessons the stress is laid on teacher's presentation, giving students a model of scientific investigation by outlining the basic stages and by illustrating them with clear and simplified examples. Students get impressions and understandings about planning, construction and performance of scientific experiments to solve problems in ecology and conservation. They receive a mental picture of scientific methods and equipment, an understanding of scientific concepts. Using Power Point presentations the teacher acquaints 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. In spite of teacher's dominance [9] we tried to create a learning environment for the students to develop their own learning strategies (table 4). .

Seminars give priority to students' presentations on studied problems 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 leaders' characteristics in students when they are allowed to lead and perform.

Expert learning offers educational process giving students nearly full autonomy. They work in small groups as a team. Every student becomes an expert in a given topic from the studied contents and plays the role of a teacher in the group thus performing peer education [10]. In our experiment students regrouped twice. First they divided into so many groups as is the number of the studied problems (or subtopics). They investigated the subtopics, discussed them in the group and after that they rearranged in new groups in such a way as each new group to have a specialist (an expert) for each subtopic [11]. Everybody in the group is a teacher to his or her partners and at the same time learns from them [12].

School conference matches learning with social activity. It is dedicated to a large topic and requires a longer period of time for preparation. Students prepare short scientific presentations and posters, science fair to show their models, songs and poems to entertain the audience. This mode of organization ensures a possibility to develop communication skills and speak fluently in public [13].

III.II. Dominant methods in the different modes of organization

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. M. Versilin and V. M. Korsunskaya. Using the verbal methods students receive information from teacher's speech – lecture, retelling, explanation, presentation, as well as from available books and articles, or from Internet. Visual methods include observation of drawings, films, experiments, tables, graphs, models and other demonstrations as well as observations of natural phenomena. Practical methods are mainly represented by manual work involved in experiments, modeling, sowing, digging etc. Combinations of the three methods combines the work of all receptors – hearing, vision, taste, touch, smell, proprioreceptors and makes the reception of information multisensual. Multimedia combines 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. 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 caching the attention 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 [12].

III.III. Students' learning activities

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). That can be achieved if the student tries

to solve learning tasks which integrate the information and learning methods from different school subjects [14, 15]. 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). For example the task presented as a problem "Should Japan receive permission to whale for trade purpose?" [16] 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 "International commission for whale preservation" under the auspices of UN (Fig.1). Students play the roles of marine ecologist, economist, statistician and nature conservationist.

Cognitive learning activity for solving the problem of whaling is concerned with searching for information about whale population size and numbers of the different species (marine ecologist and statistician), way of life, way of communication, specific behavior (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 prepare a list of checked and recommended Internet sites to look for information and offer it to the students to study it and to analyze it using statistical methods and debating in the small groups [17], critical thinking [18] and making a decision for the solution of the problem [19]. In some cases the problem is posed by the teacher and in others it is formulated by the students, which stimulates their "problem vision" [14, 20].

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

Ethical (moral) development activity is directed to responsibilities of everybody in order to protect the environment from deteriorating human actions. The problem is ethical, aesthetical and humanistic because every human being, present and future, has the right to environment of high quality. We cannot use up all our resources as the future generations, that come to life as a result of our wish, will also need them. It is immoral to give birth to people but leave them without proper environment. Besides, the humanity should continue far ahead in future – preservation of nature means preservation of human life as well. The extinction of whales will bring to many unforeseeable outcomes including extinction of other species. Rules and rights mean responsibility. Behavioral rules include constructive collaboration as well [12].

Skills development activity is utterly important. Students prepare bibliography on the problem to be studied, make tables and graphs on population dynamics, photo essay on whales biodiversity, construct maps about whales habitats, visualize the significance of Japanese economy in whaling, propose alternative economic strategies, preserve the collected information on CD, every working team prepares Power Point presentation, then the groups debate their solutions, refine them, construct meanings to the concepts and reach conclusions by consensus [12].

The obtained results help students arrive at meaningful decisions, which ensure sustainable use of resources. This is the way to achieve competence to monitor the state of the environment. Students construct arguments to support their decisions. The last stage is the pedagogical monitoring. Students assess each other, everybody assesses himself and the teacher assesses everybody. Each group is also assessed by the teacher. Students receive marks for their work in the group. They analyze the marks from the teacher and from classmates, compare them with their self-evaluation marks and develop skills for objective self-evaluation. The marks received have to be supported by arguments. In order to apply their decisions into practice they organize a campaign for whale preservation in collaboration with NGO's. At the last stage, when presenting their findings students invite their parents to attend the conferences and presentations and to enjoy their children intellectual growing up. The school thus solidifies its social image.

IV. Criteria And Methods Of Evaluation

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

Students' achievements are assessed using Bloom's taxonomy of educational objectives, which gives information about the development of their thinking abilities. The first three levels (knowledge, understanding and application) characterize empirical thinking and the next three (analysis, synthesis and evaluation) – theoretical thinking. In order to assess the achievements we used written multiple choice tests validated beforehand. The psychometric characteristics were studied and the following characteristics determined: validity, reliability, items difficulty, distracter analysis and discriminative force.

Development of specific skills and attitudes is assessed by means of questionnaires and diagnostic observations using performance based assessment. During the experiment practical and intellectual skills were assessed though it is very difficult to distinguish clearly between the two. Attitudes are assessed using statements that require 5-scale graded opinion: completely agree, agree, not very sure, disagree and entirely disagree.

Correlations between knowledge, skills and attitudes were calculated using Pirson-Brave's correlation coefficient [21].

Efficiency of teaching and learning methods was calculated using Student t-criterion [21].

V. Results and interpretations

V.I. Assessing students' cognitive knowledge and skills

Bulgarian scale for assessing students' achievements is quantitatively represented from 2 two 6. Poor 2 means failure, satisfactory 3 means pass, good 4, very good 5 and excellent 6. According to this scale students showed highest performance at the first level – knowledge (recall of information) (table 7, Fig.

2). At the next levels their success becomes lower but still stays above good 4, which means that the methods of teaching and learning we used proved to be successful. Best records showed the tenth grade students in high school and it is not surprising. The school syllabus in biology for 9th grade is dedicated to studying the Biosphere for nearly half a school year. In the 10th grade ecological knowledge is reexamined from the point of view of the evolutionary theory. The syllabus of the 7th grade includes a chapter of 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 opportunity to study ecology and to apply new methods.

V.II. Assessing students' practical and intellectual skills

In the course of the experiment we investigated 33 skills, grouped into practical and intellectual. Practical skills are assessed using the 6-graded scale according to criteria accepted beforehand. The results are shown on table 8, Fig 3. The highest achievements are obtained by involving students in autonomic studies and presenting them on posters or Power Point. These activities attract them with the new way of learning, with the independence and freedom to be inventive. Most of all the multiple attractive ways to visualize the studies fascinate them. They adore the possibility to show their intellectual capacity and dexterity.

Intellectual skills were studied in many different tasks (table 9, Fig. 4). The highest score students obtained on studying and solving cases and generating ideas using brainstorming. 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. This is understandable if we take into consideration that in the process of teaching a greater attention is given to tasks requiring intellectual skills. This is not justifiable as in real life practical and intellectual skills are very closely related, as a good theory is the best practice.

V.III. Interdependence between knowledge, skills and attitudes.

The correlation between knowledge, skills and attitudes were worked out using the coefficient of Pirson-Brave [21] (table 10, Fig. 5). The highest correlation was found between the ability of students to construct intellectual maps and their ability to conceptualize knowledge (table 10 – 8). This is a very productive method as it allows 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 real behavior of students in nature is high (table 10 – 3). A system of positive attitudes builds the values relationships towards nature, students' ecological consciousness, which in its turn acts as a factor, regulating their behavior, (table 10 – 4) and the ways they interact with natural objects and phenomena (10 – 1). Attitudes without well-organized educational process providing planned activities in which real life situations are transformed into pedagogical situations for students to conceptualize, will never give rise to development of skills and values systems, nor to nature friendly behavior (table 10 – 2). The higher the conceptualization of knowledge is, the stronger their abilities to self-evaluation are (10 – 5). Pedagogical situations for the development of these skills are also necessary as they are built with great difficulty and perseverance. Our studies show that a very small part of students can self-evaluate realistically. Most of them either overestimate or underestimate themselves according to the state of their self-esteem and self-confidence. The correlation between knowledge and competences is not high (10 – 6). We can explain that bearing in mind that competences are very complex constructions. For their successful development contributes the practical application of the five components of the conceptual construct of the innovative model of EE (see 2.4).

The relationship between empirical and theoretical knowledge also needs explanation. We expected higher correlation as in the secondary school inductive approach should predominate. 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.

V.IV. Comparative effectiveness of the different methods

Using Student t-criterion (1, c. 175) we calculated the significance of the difference between the methods of teaching and learning applied in the experiment (table 11, Fig. 1). The obtained results for t-criterion are compared with t-criterion from a table [21], which is 1.96 (α - 5 % of error). Full application of the conceptual construct of EE gives better results than partial application. 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 (table 11 – 1; Fig 1).

Modeling (creative construction of models by students) gives better results than the use of ready-made models (table 11 – 2). The same result is obtained when construction of models is compared with the demonstration of models by the teacher (table 11 – 6). Students are absorbed by their work as they are allowed to choose the material and the type of model to use. They are obliged to construct scientifically right model and to be able to explain it.

Expert learning, when students are in the position of a teacher, is more effective than learning from the explanation of the teacher (table 11 – 3). Students search and learn information on a given topic and then teach their classmates. In the working team every student is a learner in one topic and a teacher in another. Experiments and observations are much more effective than teachers' lectures, because they bring the satisfaction from obtaining first-hand evidence by students. It

is fascinating for learners to find out how the things work, to get results and to compare them with the results from scientific papers. Using scientific approach students are placed in the role of a scientist and pass 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) (table 11 – 5). Generating ideas using brainstorming and discussions is also a more effective learning than learning from lectures (table 11 – 7). Lecturing does not hold the attention of students very long. That's 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 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' satisfaction from learning and the obtained results.

VI. Conclusions

1. The experimented learning methods develop students' competences giving priority to health-environmental competency.
2. Using these methods when solving real life problems students integrate knowledge from different subjects and teachers interact and help one another in accomplishing a common educational goal – development of competences.
3. Studying and solving real life problems motivate learners to consciously seek and apply knowledge, to construct evidence and make conclusions through fruitful collaboration with one another.
4. Students get ready to social realization while still at school by accepting and playing different roles, by experiencing empathy to other people and other living things.
5. The use of innovative methods to effective learning requires adequate teachers' qualification, adequate competences and determination for collaboration between themselves, with the students and between the students involving parents as well. Parents should not stay aside when their children grow not only physically but intellectually as well.

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