APPLICATION OF CASE STUDIES FOR THE FORMATION OF ECOLOGICAL CULTURE IN PROSPECTIVE BIOLOGY TEACHERS

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Abstract

Coping with environmental pollution is a systematic challenge for public actors, economic sectors and education. In this article the methodology for the application of environmental cases in the process of training students - future teachers of biology is developed. Case solving in the learning process is based on the consideration of cases taken from practice or very close to practice that is problematic and/or difficult to solve.

The article presents a system of case studies that include primarily eco-innovation, services, and models, new solutions such as advanced household heating technologies, or innovative ways to reduce air pollution from energy use, transport and agriculture. The methods used in this study are theoretical analysis and synthesis, focus groups.

The cases developed are two main types: cases where the problem situation is described, no decision has been made and decision-making possibility is discussed and case studies that describe the problem situation, a decision or series of decisions have been made, and the correctness of the approach and the decision has been discussed.

Students' opinion on the application of the elaborated case system is that they develop skills to: identify problems and rank them in importance; assess possible solutions and choose a solution based on rational arguments; take a decision in a limited time.

Keywords: *Ecological culture, Case studies, Prospective biology teachers*

Introduction

Education is a determining factor in the social and economic development of every nation. In most governments' educational programs, education is among the main national priorities.

The modern society, influenced by the accelerated technological development and accessible information environment, is changing at a rapid pace. Human - nature and human - society relations change. People face problems (including environmental issues) that often require non-standard solutions. To this end, scientifically literate people need to be trained to identify, formulate, and solve problems. The development of natural sciences in our century requires the integration of scientific knowledge and competence into broad areas of knowledge. The main accents in the global educational area are:

- literacy - reading, mathematical, natural science;
- key competencies;
- active learning in a constructivist environment (application of problem-research approaches);
- the interdisciplinarity of learning;
- skills for self-learning and reflection;
- lifelong learning, including informal (in an extra-institutional environment) (Ball, 2017, Ballantine et al., 2017, Kahn & Agnew, 2017, Wexler, 2017, Jones, 2018).

The formation of ecological knowledge, skills, attitudes, and values of young people in their educational process, as well as their assessment, is becoming more and more global.

Systemic innovations are innovations that are characterized by fundamental changes in the way that society operates and the way that it meets its needs. Achieving major

environmental improvements requires manufacturing industries to adopt an approach that aims at integrating different elements of the eco-innovation process so maximizing environmental benefits (Dooley, 2017, Lindgren & Emmitt, 2017).

The applicability of any eco-innovative approach depends on the ability of the organization to join in such complex processes.

Integrated sustainable production initiatives (eg closed production) can contribute to environmental improvements in the medium and long-term aspect. They can be accomplished through a combination of a wider range of innovation goals and mechanisms and cover a larger area (Almeida et al., 2017, Doppelt, 2017, Luthra et al., 2017).

Material and Methods

The article presents a system of case studies that include primarily eco-innovation, services, and models, new solutions such as advanced household heating technologies, strategic urban mobility plans, or innovative ways to reduce air pollution from energy use, transport and agriculture, funding for eco-innovative solutions.

The methods used in this study are theoretical analysis, theoretical synthesis and focus groups.

Results

Ecological education in Bulgarian Educational System – an overview.

Ecological education is a lifelong practice of social learning and knowledge transmission that is carried in all spheres of life (Hautecoeur, 2002).

Chapter Three (paragraph 22), of the Pre-school and School Education Act (Pre-school and School Education Act, 2016) regulates standards for civic, health, environmental and intercultural education.

An important step towards regulating the ecological education in our country is Ordinance No. 13 on Civil, Health, Ecological and Intercultural Education (Ordinance No. 13, 2016). In the normative document, environmental education is defined as: "aimed at the formation of ecological culture, ecological awareness and ecological behavior in their mutual relationship with a view to the knowledge of environmental laws, protection, improvement, management and reasonable use of natural resources as well as protection of the natural environment and ecological equilibrium". Ordinance No13 regulates the framework requirements for the results of education in the field of environmental education for pre-school and school education - by degrees and stages. Expected results are in areas of competence: Water, Soil, Air, Energy and Climate, Biodiversity, Society and the Environment.

In Ordinance No5 of 30 November 2015 on general education, paragraph 3 (3) reads: "Supporting sustainable development principles, including ecological, economic and social dimensions and aiming at outlining a long-term vision for society, is through training on different subjects and aims to build a personal responsibility for sustainable future. "

The Comparative Review of the Standards for Different Degrees and Stages (Ordinance No. 5, 2015, Ordinance No. 5, 2016) regarding the opportunities for environmental education of students represents them as a set of knowledge, skills, and attitudes - their volume and level within the general education of students.

The modern educational paradigm is marked by trends such as humanization and democratization of learning, learning by doing, learning by experience.

Curricula analysis in Bulgaria (in the course of the training until the end of the first high school stage)

The curricula analysis shows the following trends in the formation of knowledge and skills acquisition (in the course of the training up to the end of the first high school stage):

Identifying environmental problems - identifying the problem, determining variables (what is being sought), choosing methods, judgment can solve this environmental problem from science, keyword definition.

A scientific explanation of environmental processes and phenomena - tracking causal links, anticipating changes in variable conditions, choosing an environmental model (law, dependency) to explain the phenomenon, distinguishing the cause and consequence of a given action.

Use of scientific data and evidence in an environmental context - transfer of information from one species to another, evidence, argumentation, evaluation, interpretation, comparison, and aggregation of information, justification of the conclusion, formulation of the hypothesis. The context can be personal, local, national, and global (natural resources, environmental protection, risk, etc.).

The conclusions drawn from the curriculum analysis in the context of the formation of environmental culture, environmental consciousness, and environmental behavior are:

- Center is knowledge of environmental laws, protection, improvement, management and reasonable use of natural resources;
- The center is the preservation of the natural environment and the ecological balance;
- Science knowledge is used to formulate a problem (including environmental), acquire new knowledge, explain natural processes and phenomena, make substantiated conclusions on issues related to the natural sciences;
- The features of natural sciences as part of human knowledge are a manner of studying nature;
- Natural sciences and technologies form in a certain way our material, intellectual and cultural environment;
- The skills for scientific research and scientific explanation, the identification of scientific problems, the scientific explanation of natural processes and phenomena, the use of scientific data and evidence can also be applied in an ecological context;
- The center is to discuss issues related to the natural sciences and the sharing of ideas;
- The aspect is individual, public and global: natural resources, environment, risk, etc.

Important prerequisites for environmental education are the attitude to scientific research (for example, the emergence of a scientific problem due to curiosity); the emergence of goals (drawing of working ideas, models, and theories); monitoring and experimenting capabilities, and the use of measurement data (quantitative measurements, qualitative observations, uncertainty, probability, and accuracy).

The curricula content in different countries (Duarte et al., 2017, Jovanovic et al., 2017; Borhan & Ismail, 2019) includes topical issues related to the environmental protection of waste treatment, materials and fuel extraction and processing, agricultural activities, transport, and communications, etc. Some of the reasons for their occurrence are made available in an accessible manner. Information is provided on the functioning of ecosystems, on conditions favorable to plant and animal life, on the diverse environmental problems and the negative consequences thereof.

One of the centers in formal environmental education is environmental tasks (including environmental case studies). Based on good practices and the personal experience of the authors, the peculiarities of environmental tasks are formulated:

- to "solve" real environmental problems;
- to contain the basic information regarding formulas and dependencies;
- to contain interesting and up-to-date environmental issues - to use up-to-date media data related to novelties in science, to solve topical problems, to address problems;
- to have an integrative character;

- to include assessment and attitude (empathy of the problem);
- to form environmental consciousness;
- to vary in form and difficulty (in a familiar context and require simple interpretation of the situation or knowledge of natural processes and phenomena, solving them mainly requires analysis of situations that are unknown to the students, explaining everyday situations with the means of science, knowledge of natural sciences is used in an unfamiliar context);
- require the use of mathematical knowledge and skills, such as reading and interpreting graphics, circle diagrams, histograms, comparing two or more graphics, calculating and rounding numbers, etc.

Prerequisites for responding to the variety of specific conditions, individual interests, and needs of today's students are: the compliance of educational content with an ecological focus on the needs of modern life, as well as the implementation of mechanisms for diversification of basic school content at school level (De Leeuw et al., 2015; Boeve-de Pauw & Van Petegem, 2017; Meyer et al., 2017).

The formation of ecological culture, environmental consciousness, and environmental behavior can be achieved by acquiring knowledge, skills and immediate experience in nature (Asenova & Velkov, 2014; Stevenson et al., 2014; Gray & Colucci-Gray, 2019). The features of modern environmental education are in its development based on the noosphere concept and the concept of sustainable development (Apanasyuk et al., 2019). Nature-based environmental education is holistically aimed at ecological behavior. It is related to environmental knowledge and connectivity to nature. Environmental knowledge and relatedness to nature, together, are related to eco-behavior (Otto & Pensini, 2017).

In this way, natural phenomena are easily perceived and understood. This helps to cultivate respect and love for the natural environment. Environmental knowledge is an important but distal variable, whose significant effect is fully mediated by emotions. In addition to the standard class-lesson forms of organizing the learning process, extracurricular are also used successfully (Boeve-de Pauw & Van Petegem, 2017). During the excursions, students acquire visual representations of natural objects and phenomena, perceive them in their entirety, acquire experiences related to nature, collect rich visual material and then use it in the classroom. Observing different ecosystems and the great diversity of species in them leads to a better making sense and understanding of the study material. Students recognize the need to preserve the environment and preserve its integrity - important conditions for the existence of organisms on Earth (Karpudewan et al., 2015, Liefländer et al., 2017). Experiences and outdoor work (including eco-paths), work on projects of various nature conservation organizations and others contribute to this process.

Discussion

Methodology for the application of environmental cases in the process of training students - future teachers of biology is developed

In support of these actions, the methodology for the application of environmental cases in the process of training students - future teachers of biology is developed. Case solving in the learning process is based on the consideration of cases taken from practice or very close to practice that is problematic and/or difficult to solve.

The case study is a training method that is based on problematic or difficult to resolve cases. Most often, they are taken from practice or very close to practice (Flyvbjerg, 2006, Yin, 2017, Forester, 2018).

The cases developed are two main types:

- cases where the problem situation is described, no decision has been made and decision-making possibility is discussed;

• case studies that describe the problem situation, a decision or series of decisions have been made, and the correctness of the approach and the decision has been discussed.

At the heart of the environmental case is the situation. It is a set of characteristics of the conditions the activity takes place in. The person interacts with the situation based on its experience, assessing its individual elements according to the needs. This interaction is largely automated, stereotypically, and remains like this up to the moment of difficulty - an unknown element in the situation. This may cause the initial activity to be stopped, which initiates the next stage - orientation in the situation.

The orientation in the situation is characterized by paying special attention to the elements of the situation, especially those that are related to the intellectual difficulty. As a result of the orientation, a decision is taken between the initial activity to continue or deviate from the activity started. In case of a decision to deviate from the initial activity, the problem situation starts.

In the event of a problem situation, the learner makes a full analysis of the situation and full mobilization of the resources. The reaction may be passive or active. Organized active coping with the problem situation actuates the mechanism for solving the case.

The mechanism for resolving the environmental case takes place in three main stages:

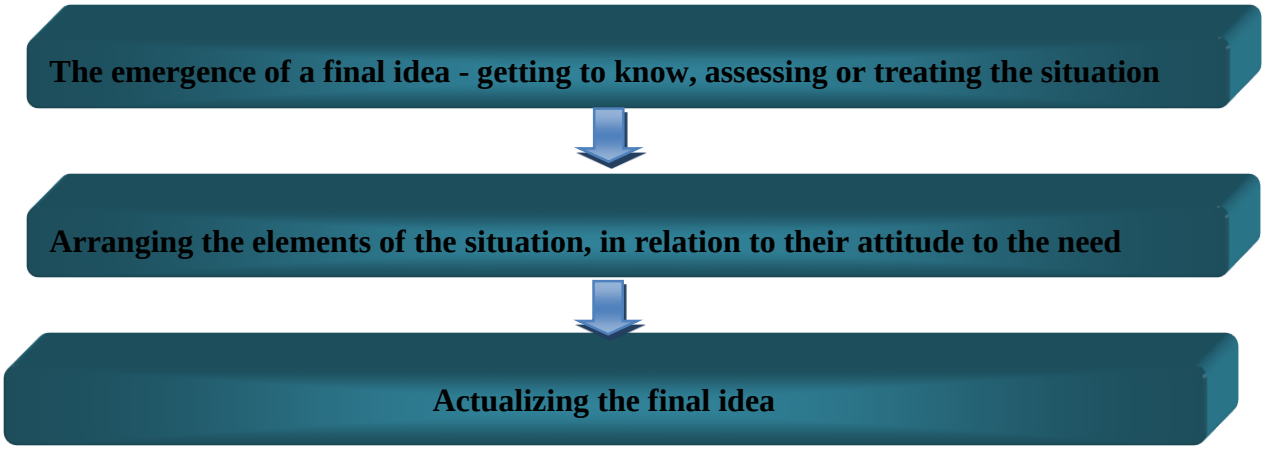

Figure 1. A mechanism for resolving the environmental case takes place

When dealing with environmental issues, getting acquainted with the situation is characterized by developmental dynamics. For example, a description of the problem situation is first provided, followed by a description of the decisions taken and their consequences, the new problems that have arisen, then the solution to the new problems and the further development of the situation, etc. The solution to the environmental case is an algorithmic description of an established, experienced way to deal with the task.

The design and application of environmental case studies for pedagogical purposes allows for "shortening" the process of accumulation of experience. Thus, variants and opportunities for a person to cope with different situations including problematic ones increase. This applies to tasks similar to life situations and tasks that are remote from real life ("the artificial" tasks). In both cases, the goal is to master a way to solve such tasks, to develop skills, to consolidate knowledge.

In the training of students future teachers of biology at Sofia University "St. Kl. Ohridski" the methodology for solving environmental cases is represented on Fig. 2. It should be taken into account that solving problems does not mean that they have to get a single answer. Training is more effective when the problems posed provide opportunities for multiple solutions, as is the case in reality - especially when it comes to more complex situations.

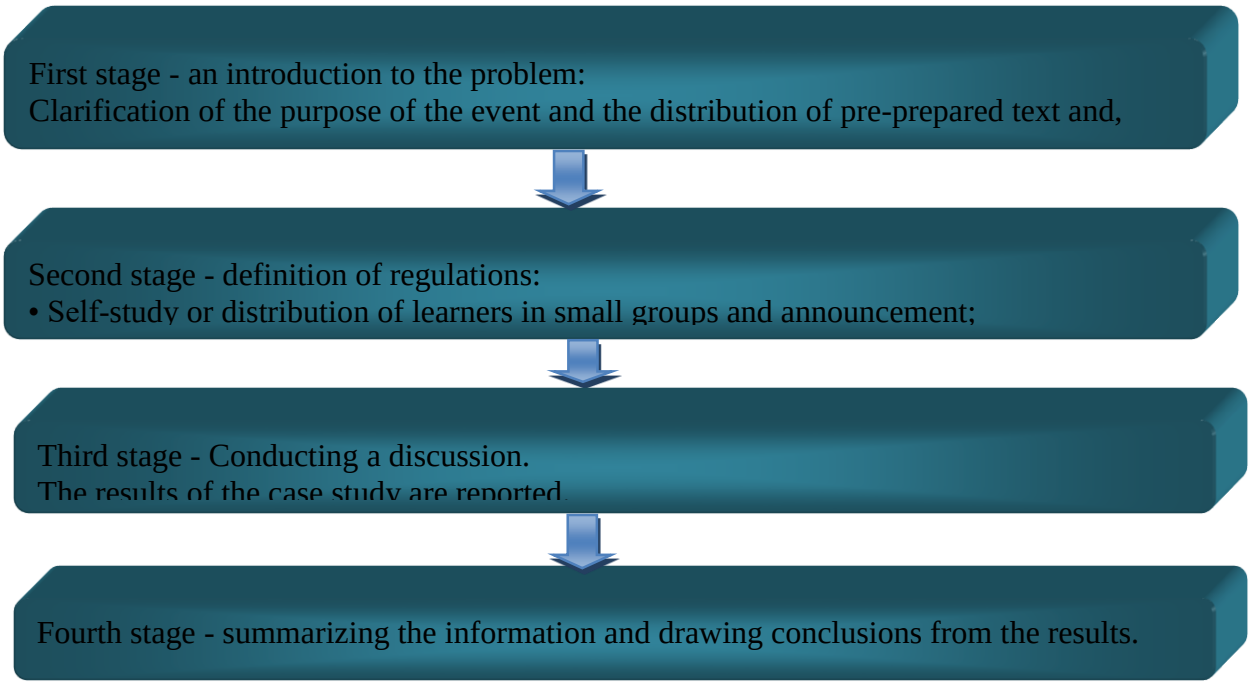

Figure 2. A methodology for solving environmental cases

Motivating opportunities in environmental cases

The motivating opportunities of environmental cases can be revealed by examining each of its structural elements in relation to motivation paths. Annex 1 presents two environmental cases that apply to the training of future biology teachers at Sofia University "St. Kl. Ohridski" (3rd year). The presented cases are related to the expected outcome of the training, the learner "predicts changes in the state of the biosphere as a result of human activity".

Students' opinion on the application of the elaborated case system is that they develop skills to: identify problems and rank them in importance (86% of 99 students interviewed); assess possible solutions (82% of 99 students interviewed); choose a solution based on rational arguments (78% of 99 students interviewed); take a decision in a limited time (86% of 99 students interviewed).

As a disadvantage of the method, students point out that it is difficult to measure the results (36% of the 99 students interviewed) and that its use can lead to a stereotyped approach to solving the problems (46% of the 99 students interviewed).

Conclusions

Attitudes towards the natural environment depend on the level of our knowledge of it. That is why environmental education needs to start at an early age. The attitude of students towards environmental protection starts from the awareness that, above all, man is responsible for everything that happens in nature. The applied method of training students – future biology students by solving environmental cases enhances their motivation and awareness of their responsibility as sitizens and professionals.That is why environmental education and schooling must be carried out very thoroughly and responsibly, starting with the well prepared teachers who at all educational stages can give support and inspiration to their students.

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APPENDIX 1

An example of an environmental case (1): Denmark's Eco-Industrial Park

One of the earliest and most famous eco-industrial parks is located in Kalundborg, Denmark. The Eco-Park is gradually being built through the cooperation of several neighboring industrial enterprises, not as a result of a carefully planned process. The main participants are coal enterprise, refinery, pharmaceutical and industrial factories, plasterboard factory, soil recovery company, and Kalundborg Municipality through the district heating facilities.

The eco-park was launched when a plasterboard factory disposed of its facilities in Kaloundborg in 1970 to take advantage of the gas butane from the nearby refinery. This allowed the refinery to stop burning that gas. Since then, the network has grown and participating companies are highly integrated. For example, a surplus of heat from the heating plant is used to heat about 4,500 private homes and the waters of a fishpond in the vicinity. The ash from the

plant is used for cement production. The sediment from the fishpond is used by nearby farms for fertilizing. Pharmaceutical plants produce insulin for pig's food. Pig farms supply the surrounding farms with waste products. The refinery supplies pure sulfuric acid, which is produced during the desulfurization process, of the sulfuric acid producer. These examples are only part of the flow of the Kalundborg eco-park, measured at a total of about 2.9 million tonnes per year, including combustion gases, sludge, ash, steam, water, sulfur, and gypsum.

- *What impact on the environment and economy does this industrial symbiosis have?*
- *Do you predict the direction in which the eco-park would develop?*

An example of an environmental case (2): Elevated radiation levels in a Black Sea bay

"Health authorities issued a new warning about dangerous radiation levels in the Vromos Bay near Chernomorets (Bulgaria). In some sections, the radiation level is up to 50 times above the norm. However, access to the beach is not prohibited, the risk of using it is the responsibility of the beach makers. A sign warns that the sandy strip is dangerous.

Ores mined decades ago from the nearby Rosen mine were rich in uranium. Part of the wastewater is discharged into the bay.

The difference in the content of radionuclides in the sand and in the soil along the sand strip in relation to this terrain compared to other terrains on the Black Sea is between 5 and 50 times more. The half-life of these radioisotope elements is over 90-100 years.

The effect of long beaching is not immediate, but it can be seen in years, warn health authorities. Small children also have the risk of swallowing sand. This can have a carcinogenic effect as well as lead to genetic mutations in the genital cells, respectively, in the offspring. This is extremely dangerous for young people and for pregnant women.

The beach is preferred by families with children. Authorities have emphasized that there is no way to forbid the use of the beach. This is the choice of people, we just have to warn them – this is the opinion of the authorities." (publication in a newspaper, 2018)

- *What measures would you take if you are a mayor of the affected area?*
- *What consequences can this have on tourism in the affected area?*
- *What eco-innovation would you apply to improve the status of ecosystems in the affected region?*