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Olena MITRYASOVA[1]
Andrii MATS[2]

HOW A NATURAL EDUCATION SHOULD ADDRESS ISSUES OF SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL PROBLEMS

The purpose of the research is the creation of an effective didactic system through the integrated approach to the content of natural education with a special emphasis on professional orientation. Methods of the analysis, synthesis of knowledge, educational experiment, and mathematical statistics were used for the fulfillment of the purpose. The effective didactic system of interdisciplinary knowledge of natural-science course, namely the water security course, was created. The educational experiment proved the effectiveness of building the educational content of the training course based on an integrated approach.

Keywords: natural education, education content, an integrated approach, water security course

1. Introduction

Improving the content of education as a strategic priority and a key direction of higher education reform was evidenced by the 2015 Yerevan Communiqué (Enhancing the quality and relevance of learning and teaching is the main mission of the EHEA), the Paris Communiqué of 2018 (the core mission of the Bologna Process and the main objective of structural reforms have been to ensure and enhance the quality and relevance of learning and teaching) and recently reaffirmed by the Rome Communiqué of 2020, inter alia, through the adoption of "Recommendations to National Authorities to Improve Teaching and Learning in higher education in the EHEA "(Recommendations to National Authorities for the Enhancement of Higher Education Learning and Teaching in the EHEA) (Ministerial Conference Yerevan 2015; Ministerial Conference Paris 2018; Rome Ministerial Communiqué 2020).

[1] Corresponding author: Olena Mitryasova, Petro Mohyla Black Sea National University, Ukraine, 68 Desantnykiv, 10, 54003, Mykolaiv, Ukraine, e-mail: lesya.solis28@gmail.com
[2] Andrii Mats, Maria Curie-Skłodowska University, pl. M. Curie-Skłodowskiej 5, 20-031 Lublin, Poland; andrejmac3@gmail.com

According to the priorities of the Rome Communiqué and the Recommendations on National / Government Support / Action to Improve Higher Education Teaching and Learning in EHEA Ukrainian higher education institutions should improve teaching and learning in in the context of student-centered and competence-based approaches, paying tribute to innovation and structured dialogue with stakeholders, taking into account data empirical research and scientific research (Rome Ministerial Communiqué, 2020). The methodology of content formation is a complex problem (Cheung & Slavin 2016; Stensaker & Fumasoli 2017; Kosmutzky & Nokkala 2020 etc.). The content of education is a system of scientific knowledge, practical skills and abilities, as well as ideological and moral-aesthetic ideas that need to be mastered during the learning process (Mitryasova 2020).

Objective factors influencing the education content include:

- the level of science and technology development, accompanied by the development of new theoretical ideas and significant changes in the improvement of technology. For example, the content of natural education required changes in the development of molecular biology, genetic engineering, green chemistry, etc.;
- the needs of modern society in the training of the younger generation (what it should be, what qualities they should have, etc.);
- the direction of state policy.

The development of the processes of differentiation and integration in the historical aspect shows that science itself has identified the means and methods to overcome the limitations of the disciplinary approach. The opposite approach is called integrated or interdisciplinary. The integration of scientific knowledge is carried out in various forms, ranging from the use of concepts, theories, and methods of one science in another and ending with the emergence of the XX century system method. Today, the latter acquires special significance because it allows us to consider objects and phenomena in their relationship and integrity.

So, one of the leading trends in the development of science is integration. Integration processes in science are manifested in the following forms: organization of research on the border of related scientific disciplines; development of scientific methods that are important for many sciences; search for general theories, principles, which could be reduced to an infinite variety of natural phenomena (for example, the hypothesis of "Great Union" of all types of fundamental interactions in physics, global evolutionary synthesis in biology, physics, chemistry, etc.); development of theories that perform general methodological functions in science (general systems theory, cybernetics, synergetics); changing the nature of the tasks solved by modern science − they become complex, require the participation of several disciplines (for example, environmental issues) (Ampatzidis & Ergazaki 2017; Ampatzidis & Ergazaki 2017a; Little & Green 2009; Mason 2009; Menashy & Verger 2019; Mitryasova et. all 2017; Ampatzidis & Ergazaki 2018 etc.).

The process of Ukraine's accession to the single European space and the signing of the Bologna Convention provides for the modernization of the content of higher education, a change in its philosophy. The culture of the XXI century ceases to be sectoral because now its development is under the sign of integration when a new type of professional must be formed, focused on innovation and addressed to the interests and values of man and society. Philosophy of the educational process of the XXI century aims at systemic pluralism, the dialogue of different concepts, the complementarity, mutual enrichment of different positions, the infinite space of opportunities for teachers and students (Ridei, Rybalko & Kycherenko 2013; Hokayem & Gotwals 2016 etc.). Therefore, the higher school faces the task of training a new generation of professionals who must meet today's requirements. Natural education has great potential to directly address sustainable development issues and environmental issues. The content of natural education is focused on integrated courses, the search for new approaches to structuring knowledge as a means of holistic understanding and cognition of the world (Hokayem et. all 2015; Munawaroh 2017; Sovhira & Dushechkina 2018 etc.). So, the research focus is a need to reorient curricula, to introduce issues developed based on an integrated approach (Nesgovorova & Savinykh 2009; An Integrated Approach 2017; Mitryasova 2020). As an example of how the content of natural education through the didactic system of an integrated approach solves the issues of understanding sustainable development, we have created an interdisciplinary training course.

The purpose of research is the creation of an effective didactic system through the integrated approach of a natural education for example of water security course with a special emphasis on professional orientation.

The object is the natural education content of the students' preparation process, namely, students' training of the environmental specialty.

The subject of the research is the content of the interdisciplinary course on water safety for students of environmental specialties of universities.

2. Methods and materials

Using partial scientific methods (component analysis of ecological knowledge, postoperative analysis of subject skills, etc.), general scientific methods (educational experiment, etc.), organizational, empirical, and methods of mathematical statistics determined the principles of selection of educational material, created the content of integrated training course, staging an educational experiment, summarized its results and analyzed the data.

To evaluate the completeness of students' knowledge and skills were defined by the ratio of the notions number of applied by students to the number of definitions that can be used. The tasks consisted of their reproductive level of educational material. The quantitative characteristic of the completeness of the

knowledge factor was the acquisition coefficient of knowledge by students. The formula 1 (Mitryasova 2020) used for this:

$$\overline{K} = \frac{\sum N_i}{n\sum N} \times 100\% \quad (1)$$

where: n – the total number of students who performed work;
$\sum N$ – the number of correct answers in the test;
$\sum N_i$ – the number of correct answers of students.

3. Results and discussions

This study is implemented by Programme EU Erasmus+ Jean Monnet Activities as part of the interdisciplinary European studies in Petro Mohyla Black Sea National University. The effective didactic system of interdisciplinary knowledge of natural-science courses, namely the water security course, was created.

Principles, meaningful lines of the integrated approach to students-environmentalists teaching are defined. The principles of selection and structuring of educational material for the preparation of students-environmentalists are defined and substantiated.

These are the principles:

- systematic (systemic factors are the goal of natural education in the context of the integrated approach, leading laws and theories, basic categorical concepts, principles of natural science, objects of study);
- interdisciplinary connections;
- fundamentalization;
- professional orientation of the education content; orientation of the content of training to the disclosure of environmental problems, such as climate change, sustainable development, environmental status of water resources (Bezsonov et. all 2017; Mitryasova & Pohrebennyk 2020).

The integrated approach to education is a special type of designing its content that opens the system of interdisciplinary communications, and it also coordinates, unites and systematizes knowledge about the main natural-science theories, basic categories, and principles of the modern natural-science picture of the world.

Levels of the integrated approach implementation are internal disciplinary and interdisciplinary of knowledge and the highest level – methodological synthesis (fig. 1). Internal and interdisciplinary integration is being implemented through selection into the content of education the facts, concepts, laws, methods, theories according to specialization and humanization. Dialectic categories are set off at the level of methodological synthesis, for example, unit, system, structure, element, cause, consequence, content, form, causality, randomness, pattern, etc.

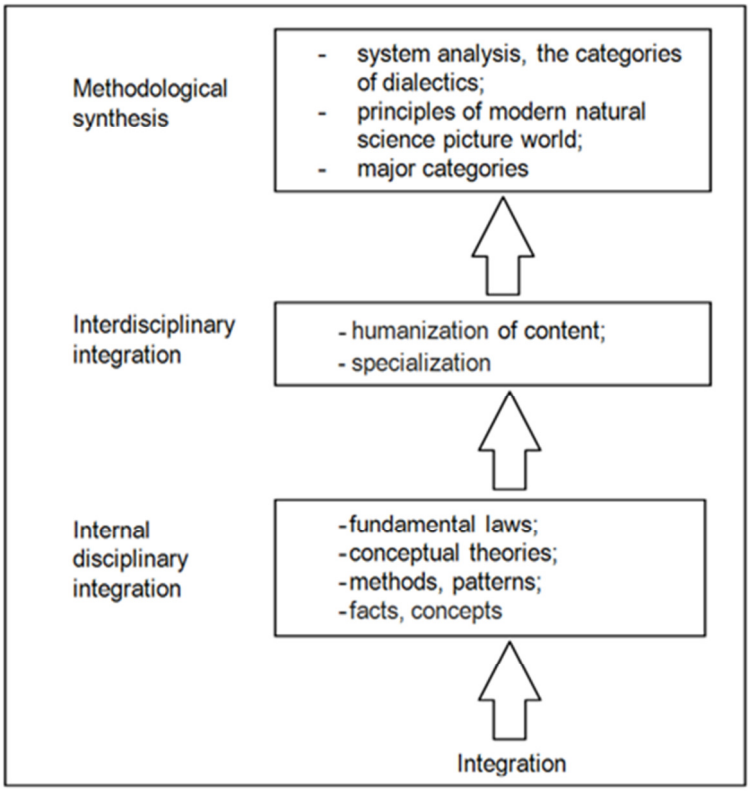

Figure 1. Levels and directions of the integrated approach implementation

The teaching course for Master's students in Environmental Science covers the main topics, such as water resources, water quality, climate change, integrated water management, water policy and law issues.

First of all, the training course presents European practices in the water security field. The content is constructed according to the leading aspects of the concept of sustainable development, namely the ideas of integration of knowledge to make optimal management decisions. The latter is based on the environmental imperative, ideas of co-evolutionary development of human, society and nature, urgent problems of climate change and issues of environmental pollution, ideas of responsibility for the quality of the environment, in particular water resources (Mitryasova & Pohrebennyk 2017). The course helps students to learn effectively on the evolution of intergraded water and environmental management of the European Union, thus to develop their awareness in the issues of European studies.

The course constructs on the interdisciplinary basis and covers key elements of the strategy for sustainable development and European experience in the field of the environmental water recourses policy (Mitryasova, Koszelnik et. all 2020; Mitryasova & Pohrebennyk 2020). The course includes such issues: water

resources; climate change; water monitoring; water pollution control; water management; water quality; water purification and European practices of water policies. As an interdisciplinary course, the one focuses the integration of environmental policy requirements into other policy areas. Also, the course compresses the international dimension, with the role of the EU in international environmental motions (e.g. Kyoto Protocol, UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development, Sustainable Development Strategies), the International Water Security Network, and so on and the impact of European policy on other regions of the world (Table 1).

The course is interdisciplinary and connects the policy and tools of water monitoring and management, principally addressing EU and Ukraine practices of water quality, water resources, biodiversity, and, fisheries and their progressive integration.

Students' learning outcomes:

- understand the difference between policies and tools of EU and Ukraine for water monitoring and management;
- explain goals and system of water management at national, regional/EU and global levels;
- understand and articulate key ecological challenges to water management;
- articulate and understanding of the evolution of systems thinking, ecosystems thinking, the ecosystem approach and ecosystem services, and the implication of this for the continued evolution of integrated water and environmental management contexts;
- understand and use topical and correct terminology related to the environmental management in the field of water security;
- ability to conduct analysis, synthesis, creative reflection, evaluation, and systematization of various information sources in researching the field of water security;
- make use of information sources about global instruments and multilateral environmental agreements as well as EU environmental policy in the field of water security;
- knowledge of the basic principles, types, methods and means of environmental water monitoring and their ability to assess and predict the state of the objects of the environment;
- understand and explain the influential quality of water to health, research and development, water security and other cross-cutting issues;
- understand of the water management system and procedures for activities of enterprises to water security, its functions, tasks at the global and national levels;
- knowledge of the latest advanced technologies and innovations in the field of water security;
- discuss the evolving policy and tools of water monitoring and management, principally addressing EU and Ukraine practices of water quality, water resources, biodiversity and fisheries and their progressive integration.

Table 1. The main content of the course

№	Topic	Main issues of the topic
1.	The role of the EU in international environmental motions (e.g. Kyoto Protocol, UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development, Sustainable Development Strategies).	History of the formation of the EU environmental foundation; the EU's place in international environmental law; EU institutions in the field of environmental protection; legal support for the concept of "sustainable development" in the EU.
2.	The strategies of EU environmental policy.	General characteristics of EU environmental policy; the United Nations Environment Programme; UN climate conferences and the EU position; United Nations Environment Programme (UNEP), UN Climate Change Conferences: Bali, Poznan, Copenhagen, Cancún Transatlantic relations and climate change / EU & US relations on environmental issues.
3.	Water and development in Europe: environmental sustainability as a precondition of European environmental policy and its best practices in water monitoring.	Water in numbers and facts; water Framework Directive as the main document for water monitoring; status of water resources; types of state water monitoring; a new order of water monitoring in Ukraine; comparative analysis of the monitoring format: as it was and how it will be; European experience in water monitoring.
4.	Implementation of sustainable development programs to post-soviet countries.	Characteristics of sustainable development content from the UN's views; the role of ecological security in the sustainable development; environmental security of aquatic ecosystems: priority factor in development; assessment of environmental component in the region's development; effectiveness of the implementation of sustainable development programs in the post-soviet countries.
5.	Water resources, water quality and climate change.	The water-resource potential of the hydrosphere; distribution of water resources; water resources of Ukraine; factors of formation of water composition; properties of natural waters; general requirements for drinking water quality in the world; requirements for water quality in Ukraine; drinking water and human health; adaptation to climate change.
6.	Integrated water management: challenges for the 21st century.	Water is the matrix of life; regional aspect of water supply: history question; characterization of water treatment stages; EU experience.
7.	Water policy and law: a comparative analysis of European and Ukrainian practices.	Water is the global agenda of the United Nations; integration is a key trend in water management; integrated flood risk management; integrated water resources management by basin principle.
8.	Urban water services: practices of developed European countries.	Water supply systems: circulating water supply; centralized drinking water supply; local or decentralized water supply; cold and hot water supply; Ukrainian experience of normalization of drinking water quality; where can we drink tap water? Experience of EU; drinking water quality standards in Ukraine and EU countries.

Table 1 (cont.). The main content of the course

№	Topic	Main issues of the topic
9.	Basics of freshwater ecology. The best practices in water purification in the EU member states.	Water policy on the definition of international waters; international water management experience; a sphere of EU influence on water policy formulation; principles of sustainable water management in Ukraine.
10.	Challenges for Ukraine in water security policy and practice due to association with the EU.	The water footprint of the country; the Urban Waste Water Directive; urban wastewater treatment plants; urban sewage treatment technology; the Marine Strategy Directive; the Drinking Water Directive; the Flood Directive; the Nitrate Directive.

Due to the peculiarities of the research tasks in the educational experiment, there were no control groups. This fact is explained by the fact that we investigated the completeness of the acquisition of knowledge of the new content of educational material according to the program created by us. It would be incorrect to create control groups where such content of educational material is not studied by students.

A test form of knowledge control was used to assess the completeness of mastering the content of educational material. The test tasks included questions of the reproductive level regarding the key concepts of the training course.

The coefficient of completeness of knowledge was determined by formula 1. The lower limit of availability is taken as a coefficient of 0.6, which corresponds to a satisfactory level of knowledge. Based on the obtained data, the quantitative processing of the results, which was carried out for each year (the experiment was conducted for three years), and then the average data were derived. It is proved that the selected educational material is quite fully assimilated by students, as evidenced by the average coefficient of 0.85.

To test the strength of knowledge and determine the degree of forgetfulness, a slice of knowledge was performed two weeks after studying the course. The coefficient of knowledge strength was defined as the ratio of the number of elements of knowledge that remained in the memory of students after some time to the sum of the elements of knowledge contained in the test. It is established that more than half of the knowledge remains in the memory of students. It is determined that the degree of forgetfulness is 3−5% of the previous ones.

Thus, in the process of forming students' knowledge, the tendency to increase their educational activity, interest in carrying out independent scientific research, in expressing original views on environmental issues discussed during classes was determined.

4. Conclusions

A didactic system of an integrated approach has been created, which has shown fairly high efficiency. This system covers the principles of selection of educational content, levels of implementation of the integrated approach. The study is proved the didactic effectiveness of the integrated approach to the form of content of the natural science course of water security. The course is interdisciplinary and connects the policy and tools of water monitoring and management, principally addressing EU and Ukraine practices of water quality, water resources, biodiversity, and fisheries, and their progressive integration. The coefficient of completeness of knowledge was determined. It is proved that the selected educational material is quite fully assimilated by students, as evidenced by the average coefficient of 0.85.

The integrated approach itself extrapolates all modern processes of the development of scientific knowledge and is relevant in the formation of the content of natural education in solving issues of students' understanding of sustainable development. The prospect of further research activities is to improve the theory and practice of the integrated study of natural courses based on the developed conceptual provisions of the education content integration, and also to improve the methodology of assessing the quality of students' knowledge during the study of integrated courses.

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