

AN INTEGRATED EDUCATIONAL CONTENT ON WATER SECURITY AS A TOOL FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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Abstract

Modern higher education requires a strategic shift toward student-centered and competence-based approaches, as emphasized by the Bologna Process and the EHEA communiqués from Yerevan, Paris, and Rome. A critical challenge remains the formation of educational content that bridges the gap between fundamental theories and professional practice. This research is supported by the Institute for Human Sciences (IWM) under the Documenting Ukraine grant. This research proposes an integrated approach to modernize environmental education, specifically through the development of an interdisciplinary "Water Security" course designed for Master's students. The study's objective was to create an effective didactic system that systematizes knowledge of natural-science theories while addressing urgent global issues such as climate change, water monitoring, and sustainable development. The "Water Security" course serves as a primary example of this model, integrating international practices, water policy, and environmental management into a cohesive module. The curriculum focuses on the co-evolutionary development of human society and nature, emphasizing the environmental imperative and professional responsibility for water resources. The methodology employed was comprehensive, including component analysis of ecological knowledge, postoperative analysis of subject skills, and educational experiments. To evaluate the effectiveness of the training, mathematical statistics were used to calculate the acquisition coefficient of knowledge. The study involved three years of experimental validation, demonstrating high didactic effectiveness. Results showed that students achieved an average knowledge acquisition coefficient of 0.85, significantly exceeding the satisfactory threshold of 0.60. The integrated approach was implemented across three distinct levels: internal disciplinary integration, interdisciplinary connections, and the highest level of methodological synthesis. In conclusion, the integrated approach to "Water Security" not only improves the quality of professional training but also fosters a co-evolutionary worldview and environmental responsibility. This model effectively extrapolates modern scientific developments into curricula, helping students master complex dimensions of environmental policy and international legal frameworks. Future research will focus on improving assessment methodologies for these integrated modules and refining the theoretical provisions of content integration to ensure the continuity of educational objectives.

Keywords: *Water security, integrated approach, sustainable development, environmental education, interdisciplinary learning.*

1. Introduction

The modernization of educational content as a strategic priority and a cornerstone of higher education reform was explicitly highlighted in the 2015 Yerevan Communiqué (which defined the enhancement of teaching and learning quality as the primary mission of the EHEA). This commitment was further solidified in the 2018 Paris Communiqué (stressing that the core mission of the Bologna Process involves structural reforms to ensure the relevance of teaching) and recently reaffirmed by the 2020 Rome Communiqué. The latter specifically introduced the "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).

Aligning with the priorities of the Rome Communiqué and subsequent national support guidelines, Ukrainian higher education institutions are tasked with refining teaching and learning methodologies. This transformation focuses on student-centered and competence-based models, emphasizing innovation, structured stakeholder engagement, and the integration of empirical and scientific research findings (Rome Ministerial Communiqué, 2020). Establishing a methodology for content formation remains a sophisticated

challenge (Cheung & Slavin, 2016; Stensaker & Fumasoli, 2017; Kosmutzky & Nokkala, 2020, etc.). Fundamentally, educational content represents a structured system of scientific knowledge, practical competencies, and ethical-aesthetic values that must be internalized during the pedagogical process (Mitryasova 2020).

The objective factors steering the evolution of educational content include:

- **The advancement of science and technology**, which introduces novel theoretical frameworks and radical technological shifts. For instance, the curriculum for natural sciences has undergone significant changes to incorporate developments in molecular biology, genetic engineering, and green chemistry.
- **Modern societal demands** regarding the preparation of the next generation (defining the necessary professional profile and personal attributes).
- **State policy directions** and national strategic goals.

The historical trajectory of differentiation and integration suggests that science itself has developed mechanisms to transcend the constraints of narrow disciplinary boundaries. This alternative is known as the integrated or interdisciplinary approach. The synthesis of scientific knowledge occurs through various modalities—from adopting concepts and methods across disciplines to the emergence of the systems method in the 20th century (An Integrated Approach to Learning, Teaching & Assessment, 2017). Today, the latter is particularly vital as it enables the analysis of objects and phenomena in their holistic interconnectedness.

Consequently, integration stands as a dominant trend in scientific development. These integration processes manifest through: the organization of research at the intersection of related fields; the creation of universal scientific methods; the pursuit of unifying theories (such as the "Grand Unification" in physics or global evolutionary synthesis in biology and chemistry); and the development of meta-methodological theories like cybernetics or synergetics. Furthermore, contemporary scientific challenges have become increasingly complex, requiring multi-disciplinary cooperation, particularly in addressing environmental crises (Ampatzidis & Ergazaki, 2017, 2018; Little & Green, 2009; Menashy & Verger, 2019).

Ukraine's integration into the European Higher Education Area and its adherence to the Bologna Process necessitate a fundamental update of educational content and philosophy. The culture of the 21st century is moving away from fragmented sectoral thinking toward an integrated paradigm, where professionals must be innovation-oriented and focused on human and societal values. The current educational philosophy promotes systemic pluralism, conceptual dialogue, and the mutual enrichment of different perspectives, offering vast opportunities for both educators and students. Therefore, universities are challenged to train a new generation capable of meeting modern requirements. Natural science education, in particular, holds immense potential for addressing sustainable development and environmental issues. Its content is increasingly focused on integrated courses and innovative knowledge structures for a holistic understanding of the world (Munawaroh, 2017). Thus, the current research focus lies in reorienting curricula and implementing issues through an integrated lens (Mitryasova, 2020). As a practical application of this approach for understanding sustainable development, we have developed an interdisciplinary training course.

2. Objectives

The primary goal of this study is to develop an effective didactic system based on an integrated approach to natural science education. This is operationalized through the design of a "Water Security" course, which places a significant emphasis on professional orientation and career-readiness for future specialists.

The **object** of this study is the content of natural science education within the framework of the professional preparation process, specifically focusing on the academic training of students enrolled in environmental specialties.

The **subject** of this research is the specific curricular content and structure of the interdisciplinary course on water security, tailored for university students majoring in environmental sciences.

3. Methods

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:

$$\bar{K} = \frac{\sum N_i}{n \sum N} \times 100\%, \text{ where} \quad (1)$$

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.

4. Discussion

This research project has integrated into the interdisciplinary European studies curriculum at Petro Mohyla Black Sea National University. The central outcome of this initiative is the development of a robust didactic system designed to impart interdisciplinary knowledge in natural science, specifically applied through a specialized course on water security.

The study defines and substantiates the core principles and thematic directions of an integrated approach tailored for the education of environmental science students. At the heart of this approach lies a set of foundational criteria for selecting and structuring educational material. These include systematization, where the goals of natural education are aligned with leading scientific laws, theories, and categorical concepts, as well as the principle of interdisciplinary connectivity. Furthermore, the content is driven by fundamentalization and a strong professional orientation, ensuring that the curriculum remains focused on critical global challenges such as climate change, sustainable development, and the current ecological status of water resources (Bezsonov et al., 2017; Mitryasova & Pohrebennyk, 2020).

In this context, the integrated approach is viewed as a specialized method of content design. It moves beyond simple knowledge transfer to create a system of interdisciplinary communications that coordinates and unifies basic categories into a modern natural-science picture of the world. This integration is implemented across three distinct levels: the intradisciplinary and interdisciplinary levels, which focus on selecting facts and methods according to specialization, and the highest level—methodological synthesis. At this superior level, students engage with dialectic categories such as system, structure, causality, and consequence, allowing for a deeper philosophical understanding of environmental processes.

The practical application of this methodology is found in a Master's level course in Environmental Science. This curriculum addresses pivotal topics, including water resource management, water quality standards, and the legal aspects of water policy. A primary focus of the training is the exploration of European practices in water security. The course content is intentionally constructed around the core tenets of sustainable development, emphasizing the necessity of integrated knowledge for making optimal management decisions.

By grounding the curriculum in the environmental imperative and the co-evolutionary development of society and nature, the course addresses urgent issues of pollution and climate change (Mitryasova et al., 2017). Ultimately, this narrative-driven approach allows students to effectively trace the evolution of integrated water and environmental management within the European Union, thereby fostering a sophisticated awareness of European standards and global environmental responsibility.

The training course is constructed upon a robust interdisciplinary foundation, synthesizing key elements of sustainable development strategies with the extensive European experience in environmental water policy (Mitryasova, Koszelnik et al., 2020; Mitryasova & Pohrebennyk, 2020). Its scope is comprehensive, addressing vital thematic areas such as water resource management, climate change impacts, monitoring protocols, and pollution control. Furthermore, the curriculum explores water quality standards, advanced purification techniques, and the nuances of European policy practices. As a truly interdisciplinary endeavor, the course emphasizes the vital integration of environmental requirements into broader policy sectors. It also incorporates an international dimension, examining the European Union's influential role in global initiatives—including the Kyoto Protocol and the UNESCO Roadmap for Education for Sustainable Development—and its collaboration with the International Water Security Network.

Beyond theoretical frameworks, the course bridges the gap between policy and practical tools for water management. It specifically contrasts and aligns the practices of the EU and Ukraine regarding water quality, biodiversity conservation, and fisheries, highlighting the progressive integration of these sectors into a unified management system.

Upon successful completion of the course, students are expected to achieve a high level of professional and analytical competence. Specifically, they will be able to:

- Discern the differences between EU and Ukrainian policy instruments for water monitoring while explaining the hierarchical goals of management at national, regional, and global levels.
- Articulate the evolution of systems and ecosystem thinking, applying these paradigms to the ongoing development of integrated environmental management.
- Identify and address key ecological threats to water security using precise, up-to-date professional terminology.
- Navigate and apply information from multilateral environmental agreements and EU-specific policy frameworks to research and practical problem-solving.
- Demonstrate knowledge of advanced monitoring methods, innovative water technologies, and the intricate links between water quality, public health, and research development.
- Conduct sophisticated synthesis and creative reflection on diverse information sources, enabling them to discuss the progressive integration of biodiversity and resource management within the industrial and corporate sectors (Table 1).

Table 1. International and European Dimensions of the Water Security Course.

Dimension	Key Instruments and Frameworks	Focus Areas
Global / International	Kyoto Protocol, UNESCO Roadmap (ESD), Sustainable Development Goals (SDGs)	Climate change mitigation, global education for sustainability, and water security networks.
European Union (EU)	EU Water Framework Directive, European Green Deal, EU Biodiversity Strategy	Integration of environmental requirements into sectoral policies, water quality standards, and monitoring tools.
Bilateral (EU-Ukraine)	Association Agreement, progressive integration of practices	Harmonization of Ukrainian water management with EU practices in fisheries, biodiversity, and resource control.

The pedagogical experiment, conducted without control groups due to the unique curriculum, confirmed high-quality knowledge acquisition with an average completeness coefficient of 0.85 and a remarkably low forgetfulness rate of 3–5% two weeks post-course. Beyond these quantitative metrics, the formative process fostered increased student engagement, stronger research motivation, and a greater capacity for original reflection on complex environmental problems.

5. Conclusions

The developed didactic system, based on an integrated approach, has demonstrated high efficiency in structuring natural science education. By defining clear principles for content selection and implementation levels, the study proved the effectiveness of this model through the “Water Security” course. This interdisciplinary curriculum successfully bridges environmental policy and management tools, aligning EU and Ukrainian practices regarding water quality, biodiversity, and resource management. Quantitative analysis confirmed successful knowledge acquisition, with students achieving a high average completeness coefficient of 0.85. The integrated approach reflects modern scientific evolution and remains highly relevant for fostering a deep understanding of sustainable development. Future research will focus on refining the theoretical and practical frameworks of integrated natural science courses and enhancing methodologies for assessing student performance within these complex educational models.

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