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PAPER

THE IMPORTANCE OF FORESIGHT METHODS IN DEVELOPING ECO-FORESIGHT COMPETENCE OF FUTURE ECOLOGISTS

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Abstract

This article analyzes the stages of developing eco-foresight competence of future ecologists through the use of foresight methods. It also highlights the theoretical foundations, methodological approaches, and ways to improve the effectiveness of using foresight technologies in the process of environmental education. According to the research results, it has been scientifically substantiated that innovative pedagogical technologies play an important role in implementing the model for the formation of eco-foresight competence.

Key words: Delphi, VORT, foresight technology, eco-foresight, eco-foresight competence, pedagogical opportunities, innovative approach.

Introduction

The intensification of global environmental problems has placed urgent tasks before humanity, such as environmental protection, rational use of natural resources, and ensuring sustainable development. As a solution to these challenges, special attention should be given to the development of future ecologists' knowledge based on modern technologies.

Currently, foresight technology is widely applied not only in education but also in the field of ecology. In particular, one of the largest and most significant ecological foresight studies is the scenario modeling of "climate change," developed by an international group of experts. Therefore, the study and application of eco-foresight technologies in the educational process of ecology is considered highly relevant from both scientific and practical perspectives today.

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In the global education system, foresight technologies are being actively implemented by many advanced countries. For example, in Japan's education system, foresight education" technologies are used to prepare learners for future environmental challenges, promote the rational use of resources, and develop programs oriented toward Green Innovation.

In the training of future ecologists, special attention is paid to the development of eco-foresight competence, the improvement of its components and criteria, the substantiation of its pedagogical conditions, and the introduction of new eco-foresight-related subjects into the curriculum.

Analysis of the Topic and Research Results

In developed countries, based on the achievements and outcomes attained in recent years, as well as the challenges encountered, scientifically grounded long-term strategic development programs for the state or region are formulated [6]. In foresight studies conducted in Japan, modern methods such as the Delphi method, bibliometrics, patent analysis, horizon scanning, artificial intelligence, machine learning, scenario analysis, and expert discussions have been widely applied [7]. In China's Engineering Science 2035 Technology Foresight program, methods including the Delphi method, bibliometrics, patent analysis, horizon scanning, scenario analysis, expert discussions, technology roadmapping, and other approaches were utilized [8]. Foresight is considered an important supporting tool for enhancing technology management capacity, improving strategic technological planning, and ensuring the optimal allocation of technological resources [9].

The methods of applying foresight in the educational process can be systematized according to several criteria as follows [4]. methods related to formalization are divided into such types as statistical methods, extrapolation, and modeling [5]. Furthermore, in contemporary studies, foresight is recognized as an essential instrument for innovation management, corporate strategy, and decision-making in sustainable development [2]. From this perspective, the VORT model serves as an effective instrument that provides a strategic-normative approach in ecological forecasting and eco-foresight research, and functions as a scientific-methodological foundation for developing the eco-foresight competence of future specialists [3].

The VORT method is an analytical approach used in foresight and strategic analysis, designed to assess the key factors determining future development on the basis of four main criteria.

Table 1.
Methodology for Applying the VORT Method to the Problem of Climate Change and Water Scarcity.

"V" - Visual (Perception and Observation) Stages			
Materials for students on climate change and water scarcity.		**Questions**	
1. Video materials 2. Photographs 3. Internet-based information 4. Exhibition materials		1. In what ways are the effects of climate change being manifested? 2. What is causing the reduction of water resources?	
"O" - Orientation Stage (Setting Directions)			
Directions	**List of main causes related to water scarcity:**		
Ecological	Reduction of biodiversity and environmental pollution		
Economic	Lack of regulated water supply, infrastructure, and energy management		
Social	Population growth, education level, and ecological culture		
Political and Legal	International cooperation and legal/regulatory framework		
"R" — Reflection Stage (Analysis and Thinking) **Purpose:** To deeply analyze the problem and evaluate the current situation.			
Directions	**Causes of Problems**	**Impacts**	**Measures**
Ecological	Global warming	Increased drought, decreased agricultural productivity	Treatment and reuse of wastewater
Economic	Improper organization of water distribution	Industrial and agricultural crisis	Introduction of innovative technologies
Social	Population growth	Drinking water scarcity	Formation of ecological education and culture
Political	Lack of international cooperation	International conflicts disagreements	Establishment of international water resource management and cooperation
"T" — Transformation Stage (Practical Solution) **Purpose:** To transform the studied ideas into practical strategies and actions.			
Goals:	**Main Tasks:**	**Implementation Mechanisms:**	**Expected Results:**
Rational use of water resources	1.Introduction of water-saving technologies 2.Modernization of irrigation systems	Implementation of innovative projects in cooperation with government and international organizations	Water consumption will be reduced by 20–30%
Increasing the ecological awareness and culture of the population	1. Promoting ecological culture in educational institutions 2.Strengthening awareness campaigns through mass media	Introduction of the "Green School" program through environmental education centers	Young people's responsibility towards global climate change will increase
Adapting to climate change	1.Introducing rainwater harvesting systems 2.Increasing the cultivation of drought-resistant crop varieties	Application of innovative agricultural technologies	Stability and sustainability of agriculture will be ensured

The VORT (Vision–Opportunities–Risks–Technologies) approach can be interpreted as a complex methodological model formed on the basis of integrating strategic foresight, risk analysis, and innovation development theories. This approach not only limits itself to forecasting possible future changes but also serves to create prospective development scenarios, identify strategic opportunities, assess risks, and define technological directions. The foresight process is characterized by its focus on systematically analyzing the long-term future in order to identify strategic areas that generate economic and social benefits [1].

Independent Task: Students select an ecological problem in their local area, develop a cause–effect–solution diagram based on the VORT method, and

Table 2.

Distribution of Lesson Time in the Teaching Process

Stages	Content	Time
Introduction	Showing the problem of climate change through a video or image and collecting students' initial opinions.	5 minutes
Main activity	Analyzing cause–effect–solution relationships using a VORT diagram and discussing in groups.	20 minutes
Visual mapping	Students demonstrate the problem through visual representations.	10 minutes
Reflection	Students express their own opinions and reflections.	10 minutes

Table 3.

Assessment Criteria

Indicators	Descriptions	Score
Problem analysis	Ability to identify relationships between causes, processes, consequences, and solutions	10
Creation of a visual map	Analysis of the problem through drawings and diagrams	10
Reflection	Independent expression of ideas and full understanding of the problem	10
Proposal of solutions	Ability to develop innovative solutions and scenarios	10

Table 4.

Stages of Applying the Delphi Method in the Teaching Process
(on the example of air pollution)

№	Stages	Classifications
1	Determining the forecasting object	Process of change in $PM_{2.5}$ concentration in major cities up to 2035
		Impact of transport emissions on atmospheric quality
		Level of air pollution under climate change conditions
2	Forming experts in the relevant field	Selection of atmospheric chemistry specialists
		Recruitment of qualified environmental engineers
		Involvement of sanitation and hygiene specialists
		Engagement of climatology experts
		Inclusion of state environmental control representatives
3	Open discussions among experts	What will be the main sources of atmospheric pollution in the next 5 and 20 years?
		What are the strongest sources affecting $PM_{2.5}$ and NO_x concentration changes?
		Which regions of Uzbekistan have the highest risk of air pollution?
4	Stage of summarizing collected results	Identification of the most frequently repeated factors and processes
		Ranking pollution sources based on environmental impact
		Classification of regions according to pollution risk level
5	Final forecasting stage	If our attitude toward the environment does not change, $PM_{2.5}$ levels in major cities may increase by 25–35% by 2035
		Strengthening green space initiatives across all regions
		Modernization of gas purification systems in industry and transition to closed-cycle production
		Strengthening environmental standards in the transport sector
		Increasing the share of green energy and hybrid transport systems
		Expanding green areas in cities
		Implementation of digital environmental monitoring systems

create an eco-foresight scenario up to the year 2035.

The Delphi method is an expert-based forecasting and decision-making approach that is widely used in complex, uncertain, and long-term processes, especially in strategic planning.

The Delphi method is based on collecting, analyzing, and synthesizing the opinions of experts who participate independently and anonymously through several rounds. In each round, the summarized results are provided back to the experts, allowing them to revise and refine their opinions.

Application of the Delphi Method in Forecasting Air Pollution

Air pollution is a complex environmental problem associated with the release of harmful substances ($SO_2, NO_x, CO, PM_{2.5}, PM_{10}$, etc.) into the atmosphere as a result of natural and anthropogenic activities. Its development is often difficult to predict accurately using purely mathematical models. Therefore, the use of the Delphi method, which relies on expert knowledge, is considered an effective approach.

Air pollution management using a scenario approach and strategic planning is an important scientific-methodological basis for the preliminary assessment of environmental risks, the identification of effective management measures, and the assurance of sustainable development.

Conclusion

In summary, the Delphi and VORT methods simplify complex environmental processes such as climate change and enhance students' environmental thinking through visualization and analytical interpretation. These approaches are effective methods that integrate visual, critical, and creative thinking skills in learners.

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