

Environmental education in Higher School

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Abstract. The importance of environmental education of the younger generation is recognized at the national and international levels. It is noted that the integration of environmental education into the system of general, professional and supplementary education as a steady interdisciplinary educational process helps continuous development of environmental literacy, environmental awareness, environmental thinking, environmental behavior, environmental culture and, in general, an environmentally oriented personality. In this regard, the aim of our research was to green engineering education in Higher School. Research methods: a theoretical analysis of scientific publications and a summary of advanced experience on ecological education, pedagogical observation and conversation, content analysis of students' written assignments and project works. As a result, the paper generalizes theoretical knowledge about environmental education and substantiates that environmental education in Higher School is possible through enriching curricula with environmental topics and applying IT and interactive technologies that involve university engineering students in environmentally oriented activities. It concludes that IT and ecology oriented interactive technologies contribute to an increase in social and ecological knowledge, development of skills for interpreting information in the field of ecology and increasing experience in dealing with various environmental problems of local, regional, national or international significance. The results presented in research supplement the theory and practice of environmental education in Higher School and can be applied to the greening of curricula of various university disciplines, which is relevant in the context of the greening of higher education.

1 Introduction

Environmental issues (climate change, ozone layer depletion, water, soil, air pollution, etc.) have been paid more and more attention in recent years, as the devastating impact on the environment is becoming increasingly evident [1, 2]. In this regard, the problem of educating an individual who is ready to carry out environmentally friendly professional activities is of great importance [2, 3, etc.]. Education in general and environmental education in particular are key processes in the development of a responsible and careful attitude towards the environment, environmental literacy, environmental awareness, environmental

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behavior, and personality environmental culture. Schools and universities play an important role in promoting environmental education and encouraging sustainable environmental practices. Overcoming a consumer attitude towards nature is possible by providing the continuity of environmental education, which ensures a gradual expansion of theoretical knowledge in the field of ecology, the study of past experience of environmental activities and the promotion of a responsible attitude towards the environment and environmentally safe behavior at all levels of education from general schools to higher education institutions [1, 4-6].

According to recent research, methodological foundations for greening higher education [1-7, etc.] and pedagogical methods and technologies improving the level of environmental education have been developed in pedagogical science [17-22, etc.]. However, the problem of environmental education of students has not been fully resolved, as evidenced by the insufficient level of development of students' environmental awareness [16], low students' involvement in personal eco-oriented practices (waste sorting, use of plastic bags, economical use of electrical appliances) that reduce harm to the environment [18], which underlines the relevance of our research. The object of our research: the ecological education at university. The subject of our research: IT and interactive technologies promoting ecological education at university. The purpose of our research: greening engineering education in Higher School. Research hypothesis: IT and interactive technology aimed at environmental education in Higher School will be effective if (1) they vary from information-oriented to practice-oriented, (2) the learning process is carried out in the context of an environmentally oriented choice in professional activity, (3) the educational content is enriched with ecology-oriented topics, (4) university engineering students get involved in solving environmental problems of regional, national and international significance.

As a result, the university engineering students will have an increased volume (in quantitative and qualitative terms) of social and ecological knowledge, they will develop skills in interpreting information in the field of ecology and expand the experience in dealing with environmentally oriented problems.

The research objectives: (1) to substantiate the possibility of greening engineering education at university; (2) to describe interactive technologies focused on environmental education of university engineering students in Higher School.

The novelty of research is that it generalizes the mechanism promoting stage-by-stage environmental education of university engineering students from students' awareness of the importance of solving environmental problems through understanding the need to acquire social and environmental knowledge and skills then their development and application in environmentally oriented activities.

The theoretical significance of research is that it substantiates the possibility of environmental education of university engineering students through enriching an educational content with environmental topics and applying IT and interactive technologies that engage university engineering students in environmentally oriented activities.

The practical significance of research is that IT and interactive technologies aimed at environmental education of engineering students enrich the practical component of environmental education in Higher School.

2 Methods and Materials

Conceptual ideas on environmental education of the younger generation of foreign [6, 8, 9, 12, 14, 17, 19, 20, 22] and domestic [1-5, 7, 10, 11, 13, 15, 16, 18, 21] authors are the theoretical and methodological basis of this paper. Theoretical analysis of scientific publications and generalization of advanced pedagogical experience on the topic of research, pedagogical observation and conversation with students, content analysis of students' written

assignments and project works were used as research methods in this paper. The research experimental base was Industrial University of Tyumen, Tyumen, Russia.

Industrial University of Tyumen provides multi-level education: general, vocational, higher (bachelor's degree, specialist's degree, master's degree, postgraduate study) and supplementary professional education. The educational process is carried out on the basis of individual educational technologies.

The experiment was carried out at 'Higher Engineering School', the education level - bachelor's degree in Oil and Gas Business and held in the 2023-2024 academic year. The experiment involved 2nd year engineering students (N=80) aged 18-19 with different socio-demographic status (graduates of different schools, city/rural residents, with/without work experience before entering the university), whose professional functions will be directly related to the development and implementation of solutions that can mitigate the negative impact of human activity on the environment.

3 Results

As a result of the analysis of scientific publications, it was established that in foreign and domestic pedagogical science the problem of environmental education of the younger generation is being considered in various aspects (Table 1).

Table 1. Results of understanding the problem of environmental education of the individual

	Results	Authors
1	the goals and objectives of continuous environmental education are generalized at each of its stages (from preschool to postgraduate) [6], one of which is 'a change in values and the transition from anthropocentrism to bioecocentrism' [1];	N. Dilova, M. Kosimova, V. Raxmanova, M. Hotamova1, and N. Kuldosheva, E. Putilova, Y. Tsiplakova, A. Diachkova, and E. Knysh
2	the application of an interdisciplinary approach in environmental education which allows students to explore environmental problems in various aspects (social, economic, cultural, etc.) has been substantiated [7];	A. Shutaleva
3	the principles (integration, continuity, focus on practice, etc.) of environmental education have been clarified [1];	E. Putilova, Y. Tsiplakova, A. Diachkova, and E. Knysh
4	the role of environmental education in schools which is to increase students' awareness, knowledge and skills in order to educate a generation capable of solving environmental problems in the future has been confirmed [8];	G. H. Permanasari, S. Suherman, and L. Budiati
5	the conditions for the effective development of environmental culture among schoolchildren have been determined, criteria for determining the level of formation of their environmental culture have been proposed [9];	G. Obidova, M. Tursunova
6	the need to orient students' behaviour toward environmental protection has been substantiated, the value aspects of environmental protection activities have been considered [10], and the features of the formation of environmental values in students have been studied [11];	R. Bazaliy, A. Barsukova
7	the main factors (personal attitude to environmental protection, consumer behavior and degree of concern for the environment) influencing students' environmental awareness	X. Peng, W. Zhang, Y. Huang

	and environmental behavior have been identified: [12];	
8	the need to develop students' environmental competencies has been recognized for preparing students for professional activities during the learning process [13];	V. Popov, N. Klycheva, J. Bolandova, E. Asmankin, P. Sukhov
9	the essence of the concept of students' pro-environmental behavior has been defined, the relationships between sources of information on environmental issues, acquired knowledge and pro-environmental behavior for environmental protection have been studied; the role of the university has been proven as a reliable source of informing students about environmental issues and a start-up for implementing pro-environmental actions [14];	Z. Ait taleb, M. El Farouki, and M. El Mejdoub
10	the component composition (an environmental worldview, environmental awareness, environmental thinking and environmental culture) of the readiness of students-future teachers to change their consumer attitude to the environment to a nature-preserving one has been clarified [15]	A. Nazarenko, I. Astrakhantseva

As a result of generalization of advanced experience, it was established that environmental education of students of various majors is implemented based on axiological, systemic and activity-based approaches within the framework of practice-oriented activities through:

1) students' immersion in solving professional environmental problems, nature conservation activities and psychological trainings in the process of teaching the discipline 'Ecology' [16];

2) organization of environmental conferences and forums, which allows students to study the environmental experience of others, deepen their knowledge in the field of ecology in accordance with the specifics of professional activity [3];

3) media education, providing awareness of environmental issues and encouraging responsible behavior towards the environment [1];

4) integration of environmental issues into the educational content of various disciplines [6, 9, 13, 17-21];

5) practical ecologically-oriented events [10], for example, weekend hikes, which helps to encourage interest in regional environmental issues and motivation in the design and implementation of applied projects related to improving regional ecology [4];

6) modified curricula emphasizing regional environmental issues [6];

7) interactive teaching methods (business games, project-based learning, etc.) helping to increase the level of environmental awareness and environmental thinking [17, 22].

As a result of theoretical analysis of scientific publications, the following is taken as a research basis:

1) environmental education of engineering students is a process of developing the environmental skills and readiness for a conscious and responsible attitude to the environment when performing professional functions of an engineer;

2) greening engineering education is a process of developing the personality of a future engineer, ensuring the acquisition of environmental knowledge and skills, values and experience of environmentally friendly activities;

3) greening engineering education is possible due to enrichment of an educational content with environmental topics and IT and interactive technologies that involve students in environmentally oriented activities at university.

Theoretical and methodological foundations of environmental education and generalization of advanced pedagogical experience allowed us to develop interactive technologies aimed at environmental education of engineering students, which consists in a gradual change in the methods of knowledge and skills assimilation from information-oriented to practice-oriented through immersing students in solving environmental problems of regional, national and international significance at university. Develop interactive technologies aim at increasing the volume (in quantitative and qualitative terms) of social and environmental knowledge, developing skills in interpreting information in the field of ecology and expanding the experience in dealing with environmentally oriented activities. Environmental education of university engineering students was carried out in the context of a socially oriented choice in professional activity at university.

Through pedagogical observation and conversation methods we established that the overwhelming majority of engineering students have some ideas of the environmental problems of the city, region or country, but nevertheless they have a neutral personal attitude towards environmental protection, to a greater extent consumer behaviour and a low degree of concern for the environment, which actualized the application of IT and interactive technologies aimed at ecological education of students.

The practical implementation of IT and interactive technologies is presented below.

1. Brainstorming. Discussing the topic 'Ecology in Industry', students brainstormed a number of associations to the concept of 'ecology'. Here are some examples: "nature, care, safety, conservation, renewal, cleanliness, health, peace, rules, recycling, globalization, future, pollution, flora, fauna, earth, water, alternative energy sources, plastic packaging, resources, etc." (from students' notes).

Reflecting on what the concept of 'ecological thinking' is, students answered: 'this is when you think about the problems of environmental pollution; environmental thinking consists of taking actions aimed at improving the ecology of the surrounding world (throwing garbage in the right place, sorting it by type, not smoking, etc.); this is a way of thinking that is a conscious attitude to the world around us; a way of thinking in which a person tries to reduce the impact on the world around us; awareness of the importance of nature, thoughts about the future of the Earth; this is way of thinking aimed at caring for the environment and preventing environmental disasters; a way of thinking that takes into account, for the most part, environmental consequences when making any decision related to a threat to the environment; this is a special mindset that is focused on preserving and maintaining the environment', etc.

They interpreted the phrase 'environmental responsibility of a company' as: the obligation to think not only about the company's profit, but also about the environment; the obligation not to harm the environment and to compensate for damage in man-made disasters; the obligation that a company must fulfill in relation to nature (ensuring its preservation; the responsibility of companies for the future of humanity, finding optimal ways to eliminate the damage caused); the development of companies in the direction of reducing harm to the environment, for example, reusing raw materials, filtering waste; reducing harmful emissions and reducing the harmful impact of humans on their environment. Some students noted that they had not previously thought about the concept of 'environmental responsibility of a company' and discovered new meanings for themselves.

2. Project activities. Using the Internet, students collected information and presented projects on the topics: 'Environmental initiatives of regional companies', 'Environmental initiatives of domestic companies', 'Environmental initiatives of foreign companies'. In cooperation students exchanged information about global environmental organizations, such as the World Wildlife Fund (WWF), analyzed its content and presented the fund's activities to prevent and reduce the negative impact of the oil and gas sector on the environment. With each task, students noted that they built up their previous knowledge regarding issues of

environmental social responsibility and realized the importance of ecology-oriented choice in professional activities.

3. Discussion of real emergency situations presented in the public domain in the media. Students described photographs with various emergency situations from the position of a professional, made assumptions about the causes of their occurrence, measures to eliminate them and the consequences (environmental, social, etc.). For example,

- 'the picture shows the moment of the explosion that occurred on an offshore oil platform. The barge was very old, so all the equipment on it was also outdated. As a result, during oil production, one of the pipes burst from high pressure, after which a strong fire engulfed the entire structure. The crew realized the consequences of what happened and tried to put out the fire with fire extinguishers, but they did not succeed, and in the end, the rig exploded. This explosion also led to the fact that the extracted oil spilled into the ocean, which led to massive pollution of the water area and the death of marine flora and fauna';

- 'in the picture we see an oil spill after an accident. All the oil has leaked into the ocean, which will have dire consequences for marine life. Both animals and marine plants that come into contact with it will die without proper assistance. Every time something like this happens, an insane amount of resources has to be spent on restoration, which takes a huge number of years';

- 'The photo shows a group of volunteers trying to get rid of the harmful effects of an oil spill. These people are unique because they really care about the environment. They are equipped with some special equipment, such as helmets and shovels. Their goal is to clean up the coast as quickly as possible'.

The university engineering students noted that a person faces ecology-oriented choices not only in professional activities, but in any activity in general, and that it is important to build interactions from the position of an ecology-oriented person. For example, while working on project 'Oil Spill in the Gulf of Mexico', the students found out that caring companies from all over the world responded to the liquidation of the consequences of the accident. The university engineering students repeatedly emphasized that economic development and meeting the growing needs of humanity is possible without causing irreparable damage to the environment, provided that professional duties are performed conscientiously.

While studying, the university engineering students discussed real emergency situations presented in the media and the reasons for their occurrence. Here is an example of a problem-based task: during towing in the open sea, a drilling platform got caught in a 10-point storm. Strong winds broke the platform's ventilation pump. As a result of flooding in the pump room, the platform capsized and sank. Everyone died. The investigation showed that the team had not been trained for emergency evacuations. Task: express and substantiate your opinion. Here some examples:

- 'the team must not work if they have not been trained for emergency evacuations. Also, towing cannot be carried out during a 10-point storm, which is considered a violation of safety regulations. The platform must be equipped with rescue boats along the entire perimeter, and during a storm, all employees must unconditionally have life jackets with them in case the platform starts to sink';

- 'I believe that all the blame lies entirely with the people who decided to transport the platform in a storm';

- 'I consider this situation unacceptable. Such a responsible operation as towing a drilling platform must be carried out by professionals who have undergone the necessary training and instructions';

- 'if the team has not been trained for emergency evacuations, then the management is negligent in its attitude to the safety of its subordinates';

- 'before carrying out work on towing the platform, it would be necessary to conduct a briefing for the team, organize a training alert so that the workers could practice their actions in an emergency. It was necessary to predict the weather conditions in advance. If a storm is possible, postpone the towing date to avoid human casualties'.

Here is another example of a problem-based task: During routine maintenance of a pipeline, engineers removed a pressure relief valve for a condensate injection pump. During the work, the open condensate pipe was temporarily closed with two blind flanges. When the maintenance crew finished their shift, the work was left unfinished. The foreman wrote in the log that the work had not been finished and the condensate injection pump they were working on should not be turned on under any circumstances. The night crew turned on the pump after another pump failed, causing gas condensate to leak from the two blind flanges. The gas ignited. Automatic fuses usually extinguish the flames, but the crew turned them off during the maintenance. There was a gas leak that caused several explosions on the platform. It took almost three weeks to fight the fire. This accident is classified not only as the largest oil disaster, but also one of the most expensive man-made accidents in history. Task for students: Express your attitude to the situation. Justify your answer. Offer recommendations for effective interaction between the team in order to avoid a similar accident in the future. From students' written answers:

'I think that the day team leader should not only have recorded the unfinished work in the log, but also personally informed the night team leader. The workers themselves should have fenced off the work site with warning tapes and notified the night team workers as much as possible in every possible way, for example, with signs';

'After completing the work, the workplace should have been fenced off and 'do not turn on' signs should have been hung up so that the night team could see the work site when patrolling the area. At the end of the working day, at the planning meeting, the team leader should inform about the work completed at the enterprise. At the end of each shift, operations must be recorded so that the new shift knows what they will have to work with, and they must sign for it. Also, after maintenance, it would be necessary to turn on the fuses that extinguish the flame;

'To avoid an accident, it is necessary not only to record the operations in the log, but also to personally report it to the night shift foreman, who passes the information on to the workers'.

Thus, the content of activities on ecological education of engineering students includes environmental oriented problems aimed at developing students' awareness of the importance of solving environmental problems, then understanding the need to acquire social and ecological knowledge, skills and abilities, and at last, mastering them in environmentally oriented activities at university.

4 Conclusion

Environmental education of university engineering students is possible through enriching an educational content with environmental topics and applying IT and interactive technologies that involve university engineering students in environmental oriented problems. The interactive technologies developed as a result of scientific publications analysis and advanced experience generalization involve step-by-step environmental education of engineering students through their involvement in dealing with various environmental problems of local, regional, national or international significance. Step-by-step environmental education of engineering students involves (1) students' awareness of the importance of solving environmental problems, (2) understanding the need to acquire social and environmental knowledge and skills, and (3) their development and application in dealing with ecological problems at university. Content analysis of written assignments and

project works of engineering students indicates an increase in the volume of social and ecological knowledge, development of university engineering students' skills in interpreting information in the field of ecology and an expansion of experience in environmentally oriented activities, which confirms the successful integration of IT and ecology oriented interactive technologies at university. The results presented in the paper can be applied to university curricula greening, which is relevant for greening higher education.

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