# Environmental education and its role in the formation of environmental knowledge and attitudes

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**Abstract.** Environmental education is an important part of specialist training. Integrated environmental education helps develop future professionals' abilities to understand the impact of professional activities on the environment, make decisions and act to prevent damage to the environment. This study examines the patterns of integrating environmental education into curricula for training engineers in the field of construction, to study the relationship between environmental knowledge and attitudes. The results showed that students' environmental knowledge and attitudes to the environment are positively correlated, but to a weak degree. The introduction of environmental education helps develop students' knowledge and understanding of environmental problems and their causes.

## 1 Introduction

The quality of human life is closely related to environmental conditions. Environmental damage such as pollution of environmental components with harmful substances, soil salinization and erosion, desertification and forest fires have affected human health, poverty and life expectancy in many regions of the world. Degradation and deterioration of the quality of the environment in developing countries usually occur due to the increase in population and intensive exploitation of natural resources to meet human needs.

Environmental problems today arise at local, national and global levels, and arise from the following factors. Rapid population growth threatens the sustainable use of natural resources, reduces the quality and quantity of natural resources as a result of their overexploitation, changes the dynamics of the natural model of use of natural resources and increases the risks of climate change. Areas with high population density face shortages of water, arable land, and environmental pollution. As a result, it is becoming increasingly difficult to adapt to rapid environmental changes.

The concept of sustainable development underlies joint efforts to overcome environmental damage and has been implemented for more than three decades. However, innovative

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technologies for predicting climate change and other facts of environmental degradation must be based on environmental awareness, which, in turn, depends on environmental education. The implementation and application of environmental education in professional activities is an important tool in preserving the environment [1, 2].

Environmental education is considered as a process of forming awareness and concern for all people in the world for actions to preserve the environment [2]. Environmental education helps in solving environmental problems. At the same time, the educational process focuses on identifying factors of the physical and social environment that cause changes in the environment and affect people. Environmental education forms knowledge, behavior, values, interaction for the preservation and development of the environment, quality of life for individual groups of the population and society as a whole [3]. In addition, environmental education fosters responsibility in people for local and global environmental issues. When people are more aware of the environment and related issues, they are more motivated to act more responsibly towards the environment [4]. Through the environmental education system, future professionals acquire skills that contribute to productivity, as well as the maintenance and conservation of nature. Environmental education can be implemented in various ways, and is often expressed in individual and voluntary actions to improve the quality of the environment [5]. Environmental education serves to increase environmental awareness, protect natural resources and ecosystems.

Researchers studied intentions and actions to improve the environmental situation. More and more people take measures to preserve the environment. They save energy, participate in environmental campaigns, buy products from environmentally friendly manufacturers, use less water and contribute to waste collection, participate in animal protection, and sort household waste for recycling. Environmental protection can be effectively strengthened if people become more involved in environmental protection activities [2].

There are numerous studies on environmental education in the literature. Many studies examining environmental awareness and attitudes towards the environment have shown that most participants develop positive attitudes towards the environment after completing educational programs with an environmental component [3, 6, 7].

Some studies question the relationship between environmental education and factors such as gender [8, 9], year of study and field of study [10], environmental literacy, environmental awareness [11, 12] and attitude towards environmental education [13, 14].

A number of experimental studies have been conducted, and it has been found that practice-oriented activities influence the increase in the effectiveness of environmental education. It can be seen that environmental education helps students to better know and understand the environment, forms environmental ethics, environmental skills, and helps to implement environmental practices [15, 16].

Thus, environmental education covers many aspects, including natural resources, social, cultural, religious, spiritual, economic, technological aspects. By the nature of the content, environmental education is interdisciplinary, it permeates and connects many disciplines. This pattern determines the use of an integrative approach in environmental education at a university, it implements the principle of integration in any component of the pedagogical process, ensures its integrity and systemic nature.

Teachers of technical universities should understand and recognize the importance of environmental education and integrate the content and practices of environmental education into the teaching of their discipline. We are talking about four elements of environmental education: 1) knowledge about the environment, including knowledge of natural resources and the human-made environment; 2) transmission of knowledge about the environment; 3) target group of students; 4) achievement of the goals of environmental education, namely: acquisition of environmental knowledge; attitudes and values related to the environment;

awareness of environmental problems; skills in solving environmental problems, participating in their solution and evaluating their solution [17].

Successful environmental education and training is facilitated by active and collaborative learning methods. Active learning focuses on engaging and interactive learning activities through a variety of practices with activities undertaken to develop critical thinking, communication, presentation and use of appropriate information technology skills. Active learning methods help to develop ideas, solutions and apply knowledge. Students can participate in the organization of learning and sharing experiences through cooperation rather than competition. There is also an opportunity for personal growth for students [18].

The use of the method of cooperative learning, according to R. P. Estebanez, allows creating conditions for active joint educational activities of students in different educational situations and leads to good results [19]. Students with psychological compatibility work in small groups of 3-4 people, completing a common task, and each student completes a separate task within the common task. Students take the individual task more seriously, ask questions, participate in the discussion, when they clearly understand that they are responsible not only for its completion, but also for the overall result of the small group. In such an environment, strong students will be able to fully reveal their abilities, test their point of view, help colleagues, together they study and understand the essence of the problem. This is how cooperative partner learning for students arises, in which the student's activity develops, a greater incentive for independent learning appears.

The introduction of environmental education into the curricula of industrial and civil engineering is caused by the need to expand the knowledge of future specialists about environmental degradation and environmental damage due to construction activities. In addition, students will develop attitudes aimed at reducing the risk of environmental damage. Simultaneous learning processes throughout the training period will contribute to the development of skills and abilities for solving environmental problems.

This study examines the features of the implementation of environmental education in a civil engineering university. The focus of the study is the composition of the curriculum of a construction university and the procedure for implementing environmental education. The study also examined and compared the level of environmental knowledge and environmental attitudes of university students before and after completing the retraining program “Ecologist in Construction” through integrated educational activities on environmental education using active learning methods.

## 2 Methods and materials

The research was conducted at the Moscow technical university. The research sample consisted of 73 students studying in the Industrial and Civil Construction program and who had completed the retraining program "Ecologist in Construction". Students were informed that they were taking part in a study on environmental knowledge and attitudes and participated on a voluntary basis.

The curriculum for training in the field of "Industrial and civil construction" was analyzed from the point of view of the environmental focus of the disciplines. Quantitative data collection was carried out by compiling a list of environmental disciplines from the curriculum of a construction university and calculating the percentage of implementation of environmental education in three aspects: cognitive, affective and behavioral. Then, the percentage of courses and disciplines that develop students' competencies in three focuses of knowledge was calculated: knowledge of issues, knowledge of problems and problem solving.

The study used a test to identify the level of environmental knowledge and a questionnaire on attitudes towards environmental care. The test scale was a 5-point Likert scale.

Respondents were asked to assess the degree of agreement with each statement of the questionnaire, choosing one answer out of five: 1) never, 2) rarely, 3) sometimes, 4) often, 5) always. Then, the final average scores for environmental knowledge and environmental attitudes were identified among bachelor's students before and after completing the retraining program "Ecologist in Construction".

Correlation analysis was used to determine the presence and level of correlation between the variables: environmental knowledge and attitudes towards caring for the environment among university students. The statistical program IBM SPSS 22 was used to process the data.

## 3 Results

Analysis of the curriculum in the field of training “Industrial and civil construction” was conducted to identify the degree of implementation of environmental education. The curriculum contains 45 engineering disciplines, eight of which are practical courses. Classes are designed to develop students' knowledge of the structure of the capital construction process, construction management, and construction materials. The goals of educational activities are aimed at developing three aspects of cognition: cognitive, affective, and behavioral.

The cognitive aspect is the mental activity that enables a person to relate, evaluate and think over a situation. There are six levels of cognitive abilities: knowledge, understanding, application, analysis, evaluation and creation [20]. The affective aspect indicates the development of a person’s thinking, attitudes and relation to action. This aspect is manifested in the tendency to receive information, react, evaluate, organize or manage. The behavioral aspect is characterized by the ability to imitate, readiness to act, ability to react, adapt to new conditions.

The results of the analysis depending on the nature of the work programs of the disciplines and the learning objectives show that most disciplines develop the cognitive aspect. Following Bloom's taxonomy, knowledge is the ability to record problems and related concepts. Then, with the help of the acquired knowledge, students can build explanatory mechanisms for events. The next level is the ability to apply the concept in practice when solving a problem [21].

Based on the grouping, the distribution was calculated for the cognitive, affective and behavioral aspects of the students before undergoing the retraining program: 71%, 28%, 13%, respectively. According to the results, the affective and behavioral aspects demonstrated a small percentage compared to the cognitive one. A relationship was found between the content of educational materials and the development of environmental knowledge in students. This knowledge is manifested in the ability to understand the causes and find solutions to environmental problems. The levels of development of environmental knowledge in three components - understanding, causes, environmental management, were: 58.6%, 41.3%, 21.9%, respectively.

The amount and practical applicability of environmental knowledge can be displayed by levels of environmental education, from 0 to 3. According to the results of the analysis, most of the academic disciplines integrate environmental education at level 1 (familiarization with environmental problems). 13 disciplines were identified that were included in the category of level 0, because they do not provide systemic knowledge of environmental problems. The smallest number of disciplines corresponded to level 2 (provide knowledge of environmental problems and their causes), 14 disciplines - at level 3 (provide knowledge of environmental problems, their causes and methods of rational resolution).

For example, a course in physics provides knowledge about environmental problems and their causes, so this course corresponds to the category of level 2. A course in timber construction explains the reasons for cutting down forests to obtain timber used in

construction. In addition, this course also explains how to use timber properly, using efficient methods, minimizing damage to forest ecosystems. Thus, this course belongs to level 3. The course “Construction materials” introduces a range of environmental issues: waste management, flood prevention, water pollution, air pollution and forest management. The objective of the course is for students to understand how to use construction materials in the best possible way without risking environmental damage (level 3). The course "Assessment of Buildings and Structures" explains the importance of conducting a building assessment procedure to detect defects. Assessment activities are usually carried out when a building is damaged, has been in an accident, is dilapidated or has not been maintained for a long time. The assessment results help to determine the type of damage to the structural elements and to take the following steps: to repair if the damage is minor or moderate; in case of significant damage, demolition is necessary. Demolition activities result in the generation of waste that cannot be fully reused.

Analysis of the development of environmental education content allowed us to identify ten most important topics and problems of environmental education. They are given below, with an indication of the frequency of mentioning each topic in the students' responses before completing the retraining program. Waste collection and disposal - 21%, air pollution - 14%, water purification - 10%, global warming - 10%, flood management - 8%, land depletion - 8%, soil salinization - 7%, forest management - 6%. In response to the question about the main air pollutant in the city, the option "motor transport" was chosen by about 67% of respondents, about 25% of respondents indicated industrial enterprises, no clear predominance was found for other pollutants.

The study examined students’ environmental knowledge and attitudes, a list of which was compiled based on a study of scientific papers [4, 11, 21] (see Table 1).

**Table 1.** Knowledge and attitudes of environmental orientation.

| | |
|---|---|
| Knowledge | 1. Knowledge of environmental issues in everyday life |
| | 2. Knowledge of the causes of environmental problems |
| | 3. Knowledge of the impact of environmental issues on professional activities |
| | 4. Knowledge of approaches to solving or alternative ways of solving environmental problems |
| | 5. Knowledge of human dependence on the environment |
| Attitudes | 1. Showing concern for the environment |
| | 2. Opinions and position on environmental protection issues |
| | 3. Respect for the opinions and views of others on environmental issues |
| | 4. Evidence and logical arguments on environmental management issues |
| | 5. Openness to discussion of various environmental management issues |

The results of the environmental knowledge test and the questionnaire on attitudes towards caring for the environment were processed to obtain a final average score based on the indicators.

The results of the study showed that the highest level of environmental knowledge, before completing the retraining program, was among 35.6% (26 respondents). Concern for the environment was considered as a readiness to take preventive measures to protect the environment and develop strategies to restore natural systems that have been disrupted. According to the results of the study, it was at a low level, 16.4% (12 respondents).

A comparison of the levels of environmental knowledge and environmental attitudes among undergraduate students was conducted before and after completing the retraining

program "Ecologist in Construction", using the "pretest-posttest" design on one sample of students. The results of the comparison of the average score of the indicators "Knowledge of the Environment", "Ecological Attitudes" are presented in Table 2.

**Table 2.** Results of comparison of the average score of indicators in pre-test and post-test.

| Factor | Pretest | | Posttest | | | |
|---|---|---|---|---|---|---|
| | $\bar{x}$ | SD | $\bar{x}$ | SD | t | df |
| Environmental knowledge | 37.46 | 5.73 | 58.25 | 3.09 | -31.58 | 72 |
| Environmental attitudes | 22.47 | 0.44 | 26.28 | 0.28 | - 23.6 | 72 |

* $p < 0.05$ (N = 73)

There was a statistically significant difference between the average score on environmental knowledge and environmental attitudes among undergraduate students before and after completing the retraining program.

The average score on environmental knowledge among students after completing the retraining program in the post-test was higher than in the pre-test among the same students.

This result can be associated with teaching and learning activities using integrated learning. This teaching model integrates environmental education into the content of the undergraduate curriculum, using active learning methods.

## 4 Discussions

Environmental education has been successfully implemented in the industrial and civil engineering curriculum. The dominant aspect of environmental education is the cognitive aspect or understanding of environmental problems. In contrast, the development of skills, the behavioral aspect of preventing the risk of environmental damage was expressed weakly, both before and after completing the retraining program "Ecologist in Construction". Thus, the implementation of environmental education in universities has little effect on the formation of the attitude of civil engineering students to environmental protection. According to the results obtained, environmental education can help students accumulate knowledge, identify and classify types of environmental damage. But the ability of students to find solutions to environmental problems was relatively small.

Teachers should be aware of the importance of developing integrated environmental teaching methods in a specific discipline. Effective methods include introducing local environmental issues related to construction development. Local issues can be described in detail, explored, and easily understood by students. It is useful to use the experiential learning method or providing students with direct experience that is transformed into knowledge. For example, students' understanding of landslides and accidents that occurred during construction work led engineers on site to take preventive actions. Experiential learning was consistent with Kolb's learning cycle, which consists of four stages: 1) gaining new experience, 2) reflection (analysis), 3) theoretical justification, 4) experiment [22].

The stage of gaining new experience provides opportunities for discussing environmental problems associated with construction work. The stage of reflection encourages students to be able to conceptualize the problem and describe it systematically, including environmental damage. The stage of theoretical justification encourages students to develop their thoughts on appropriate actions to solve environmental problems. The stage of experimentation stimulates students to express their opinions, perceptions of environmental problems, attitudes towards them, and propose their own methods for solving them.

According to the results, the affective and behavioral aspects demonstrated a small level compared to the cognitive: 28%, 13%, 71%, respectively. A number of researchers found that students after training using the learning community and active learning methods had higher knowledge of ecology, waste management, academic achievements in environmental disciplines [13, 16, 23]. Thus, there was a greater increase in environmental knowledge than in learning conditions without using these methods.

To obtain quality ecological knowledge, cooperation between students and teachers and project consultations are necessary. Students must also interpret what they have been taught, integrating their experience in different aspects: behavioral, cognitive and mental [24].

The results of the regression analysis showed that environmental knowledge and students' attitudes towards caring for the environment (before completing the retraining program) were positively correlated with a value of 0.2527, which indicates a weak relationship between environmental knowledge and attitudes. Such a weak relationship can be explained by the low value of environmental knowledge for students in combination with highly expressed attitudes towards caring for the environment.

From the point of view of J. Piaget's theory of cognitive development, if knowledge about the environment increases, attitudes towards caring for the environment should also become more pronounced, that is, cognitive development cannot be separated from affective development, which means that in parallel with a person's cognitive development, his (her) attitudes will also develop, a significant connection is formed between knowledge and attitudes [25]. A person's knowledge indirectly affects his attitudes or behavior. I. Ajzen and M. Fishbein argued that knowledge forms the basis for the formation of beliefs, and beliefs are considered to determine attitudes [26].

Developing students' knowledge and attitudes will enable them to prepare graduates who are highly prepared for the workforce. Environmental education in higher education institutions is also necessary to prepare qualified personnel who are able to cope with complex situations. Civil engineering education requires good structural analysis skills, and graduates should also have a developed sense of environmental responsibility. This will enable them to take appropriate actions in the design, documentation and implementation of construction projects with minimal impact on the environment [22]. The above illustrates that environmental education is an important part of developing a comprehensive resource for future professionals, and the policies and content of higher education should encourage the practical implementation of environmental knowledge.

## 5 Conclusion

The application of environmental education in industrial and civil engineering programs usually focuses on students' cognitive development, developing students' knowledge of environmental issues. At the same time, the development of affective and behavioral aspects is relatively limited. The dominant issues that become the topics of environmental education are: waste management, air pollution, water purification.

Universities should formulate appropriate models of integrated education using local and international knowledge of environmental damage. Integrated learning activities, the use of cooperative learning and active learning methods, and a centered approach to learning enable students to acquire environmental knowledge and skills in small groups. At the same time, experience is accumulated in real-life work settings.

Students' environmental knowledge was not fully expressed in attitudes of concern for the environment. Awareness of the importance of protecting the environment is still at the stage of understanding and is little translated into practical actions.

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