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Article

Methods and Criteria for Assessing the Environmental Competence of Future Natural Science Teachers

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Abstract: This article analyzes the methods and criteria for assessing the environmental competence of future natural science teachers. The study examines the essence of environmental competence, its structural components, and its role in the process of pedagogical assessment. In addition, the main diagnostic methods used to assess environmental competence such as testing, questionnaires, observation, project-based assessment, portfolio assessment, and expert evaluation are scientifically substantiated. The research findings demonstrate that a comprehensive assessment of environmental competence contributes to identifying and developing teachers' environmental knowledge, practical skills, and environmental culture.

Keywords: Environmental Competence, Natural Science Teachers, Environmental Education, Assessment Criteria, Pedagogical Diagnostics, Sustainable Development, Environmental Culture

1. Introduction

In the context of globalization and the growing severity of environmental problems, the development of environmental competence among future natural science teachers has become one of the key pedagogical tasks. Environmental competence encompasses an individual's responsible attitude toward nature, environmental knowledge, practical skills, and environmental culture[1].

The environmental competence of future natural science teachers can be defined as a combination of environmental knowledge, practical skills, values, and responsible attitudes possessed by prospective teachers of biology, geography, chemistry, and other natural sciences. It reflects their readiness to protect the environment, understand environmental problems, and foster environmental culture among students. Methods for assessing the environmental competence of future natural science teachers represent a set of pedagogical diagnostic tools used to identify, analyze, and evaluate students' levels of environmental knowledge, practical skills, environmental values, and preparedness for pedagogical activity[2].

The criteria for assessing the environmental competence of future natural science teachers constitute a system of scientifically grounded indicators used to determine and evaluate students' environmental knowledge, practical skills, environmental values, and readiness for environmental activities. These criteria make it possible to identify and analyze the level of environmental competence formation among future teachers[3].

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2. Research Methodology

This study aims to identify the methods and criteria for assessing the environmental competence of future natural science teachers. The research is based on methodological approaches grounded in the theories of pedagogy, environmental education, and the competence-based approach. During the research process, a number of general and specialized scientific methods were employed. First, the method of analyzing scientific and pedagogical literature related to the research problem was used to examine the concept of environmental competence, its structural components, and the criteria used for its assessment. In this process, the scientific views of both domestic and international scholars on environmental education and the competence-based approach were analyzed[4].

In the theoretical part of the study, the methods of analysis and synthesis were applied to clarify the essence, structure, and pedagogical significance of environmental competence. In addition, the methods of generalization and systematization were used to substantiate the main components of environmental competence, namely the cognitive, activity-based, value-motivational, and reflective components. The comprehensive application of these methods made it possible to ensure a holistic and objective assessment of the environmental competence of future natural science teachers. The results of the study are significant as they contribute to the development of environmental competence and to improving the effectiveness of environmental education[5].

In the modern education system, the increasing severity of environmental problems has made the development and assessment of environmental competence among future natural science teachers an urgent pedagogical issue. Environmental competence is considered an integrative quality that encompasses an individual's environmental knowledge, practical skills, values, and readiness for environmental activity[6].

Pedagogical scholar I. A. Zimnyaya interprets competence as an integrative quality of an individual based on knowledge, motivation, and experience of activity. According to her, competence implies not only possessing knowledge but also the ability to apply it effectively in practical activities. From this perspective, environmental competence reflects the readiness of future teachers to apply environmental knowledge in pedagogical practice [7].

Researcher A. V. Khutorskoy defines competence as a set of knowledge, skills, and experience necessary for effective performance within a particular field of activity. He emphasizes that the process of competence assessment should take into account not only theoretical knowledge but also practical activity [8].

Ecologist N. F. Reimers, who studied issues of environmental education, associates environmental culture with a conscious attitude toward nature and a system of environmental knowledge. According to the scholar, the process of environmental education should foster a responsible attitude toward environmental protection [9].

Various pedagogical diagnostic methods are used to assess the environmental competence of future natural science teachers. For example, testing makes it possible to determine the level of students' environmental knowledge. Questionnaire and survey methods are used to examine their environmental values and attitudes toward nature. The observation method helps evaluate students' environmental activities and their level of participation in the learning process. The project method allows for the identification of students' practical skills in analyzing and solving environmental problems.

Pedagogical researcher V. A. Slastenin emphasizes that competence assessment in the educational process should have a comprehensive character. In his view, the assessment process should encompass students' level of knowledge, practical activities, and personal qualities [10].

The criteria for assessing environmental competence usually consist of several structural components. The cognitive criterion determines students' knowledge of ecology and environmental protection. The activity-based criterion is used to evaluate practical skills related to solving environmental problems. The value-motivational criterion reflects

a student's responsible attitude toward nature and their level of environmental culture. The reflective criterion demonstrates a student's ability to analyze and evaluate the outcomes of environmental activities[11].

Thus, the methods and criteria for assessing the environmental competence of future natural science teachers make it possible to comprehensively identify their environmental knowledge, practical skills, and environmental values. This, in turn, contributes to enhancing future teachers' readiness to foster environmental culture among students.

At present, the intensification of environmental problems, the need for the rational use of natural resources, and the integration of sustainable development principles into the education system have made the development of environmental competence among future natural science teachers an important pedagogical task. Natural science teachers play a crucial role in shaping students' environmental knowledge, responsible attitudes toward nature, and environmental culture.

Therefore, environmental competence includes several interrelated components[12].

Cognitive (knowledge) component. The cognitive component plays a significant role in the environmental competence of future natural science teachers. This component includes theoretical knowledge related to the fundamentals of ecology, environmental protection, the rational use of natural resources, and sustainable development. It also involves students' understanding of the interrelationship between nature and society, their ability to identify environmental problems, and their knowledge of possible solutions.

Activity-based (practical) component. Another important element of environmental competence is the activity-based or practical component. This component reflects students' ability to apply environmental knowledge in practical activities. It includes skills such as analyzing environmental problems, developing environmental projects, organizing environmental activities, and effectively conveying environmental knowledge to students[13].

Value-motivational component. The value-motivational component is also essential in the environmental competence of future natural science teachers. This component reflects students' careful and responsible attitude toward nature, their environmental responsibility, and their readiness to support the principles of sustainable development. Environmental values help shape an individual's internal motivation for environmental activities.

Reflective component. The reflective component is another important element of environmental competence. It represents students' ability to analyze their environmental activities, evaluate their pedagogical practices, and improve methods of environmental education. Reflection plays a significant role in teachers' professional development, as it enables them to analyze and improve their pedagogical activities. Through a reflective approach, future teachers can evaluate the outcomes of their work and organize the environmental education process more effectively.

Thus, the environmental competence of future natural science teachers represents a complex pedagogical system that integrates environmental knowledge, practical activities, values, and reflective abilities. The harmonious development of these components ensures that future teachers are prepared to foster environmental culture among students and contributes to improving the effectiveness of environmental education[14].

3. Results and Discussion

The assessment of the environmental competence of future natural science teachers is not limited to determining theoretical knowledge alone. In modern approaches, environmental competence is viewed as an interconnected system that includes knowledge, skills, values, motivation, reflection, and practical behavior. Therefore, the integrated application of various assessment methods is essential. Within the framework of education for sustainable development, UNESCO emphasizes the importance of

developing not only knowledge but also competencies such as responsible decision-making, the ability to analyze one's own actions, and the capacity to find sustainable solutions in complex situations. Likewise, North American Association for Environmental Education highlights that the assessment of environmental literacy should consider knowledge, dispositions, competencies, and behavioral components simultaneously.

1. Testing method. The testing method primarily serves to identify the cognitive component of environmental competence. Through this method, students' theoretical preparedness in the areas of ecological fundamentals, environmental protection, climate change, the rational use of natural resources, and sustainable development can be assessed. Tests may be designed in the form of closed-ended, semi-open, or open-ended tasks. Such tasks make it possible to evaluate factual knowledge, understanding of conceptual relationships, recognition of cause-and-effect connections, and the ability to approach environmental problems from a scientific perspective. The North American Association for Environmental Education indicates that, in assessing environmental literacy, it is necessary to consider not only knowledge but also cognitive skills. Similarly, documents from the Organisation for Economic Co-operation and Development and UNESCO emphasize that education for sustainable development should assess knowledge in connection with real-life decision-making and actions.

2. Questionnaire (survey) method. The questionnaire method is an important tool for identifying students' environmental views, values, levels of environmental concern, attitudes toward nature, and sense of environmental responsibility. This method is particularly effective in examining the value-motivational component, as tests mainly answer the question "What does a student know?", whereas questionnaires reveal "What does the student believe?", "What attitudes do they hold?", and "Which values do they support?". In empirical studies, questionnaires that include indicators such as knowledge, attitudes, concerns, and behaviors are frequently used to measure environmental literacy. For example, a study conducted in Turkey on the environmental literacy of science teachers used questionnaires based on the components of knowledge, attitude, use, and concern. In another study conducted in Saint Lucia, a special questionnaire covering attitudes toward the environment, knowledge, and everyday environmental behavior was applied.

3. Observation method. The observation method allows the environmental competence of future teachers to be assessed within the context of real pedagogical and practical activities. In this approach, students' classroom participation, involvement in discussions of environmental issues, responses to problem situations, ability to work collaboratively, demonstration of environmental initiatives, and the quality of completing practical tasks are examined. The advantage of this method lies in the fact that it is not limited to written responses but captures the direct manifestation of competence in practice. Research in teacher education indicates that written portfolios or self-assessments do not always fully reflect actual practical competence; therefore, it is recommended to combine observation, classroom performance, and other assessment methods. The Organisation for Economic Co-operation and Development also recommends integrating teacher evaluation, observation, self-assessment, and peer feedback as part of modern assessment practices [15].

4. Project-based method. The project-based method is one of the most effective approaches for identifying the practical and integrative aspects of environmental competence. Within this method, students select a specific environmental problem, analyze it, define objectives and tasks, develop possible solution strategies, and present practical outcomes. During such activities, the application of environmental knowledge, research skills, creativity, collaboration, responsibility, and reflection are manifested simultaneously. Studies on the preparation of future teachers indicate that the project method has a positive impact on the development of professional competencies,

particularly by enhancing independence, communication skills, self-assessment, and readiness to solve practical problems. In the research conducted by Rusyn and colleagues, the project method is identified as an effective tool for developing the professional competencies of future teachers.

5. Portfolio method. The portfolio method enables the dynamic assessment of a student's environmental competence over time. A portfolio includes a collection of a student's academic works, environmental research, project materials, presentations, results of practical activities, reflective writings, and other supporting evidence. The importance of the portfolio lies in its ability to demonstrate not only a single outcome but also the trajectory of a student's development. Studies in teacher education show that portfolios are widely used to assess the professional competence of student teachers; however, it is recommended that they be complemented with observation and other assessment methods. Research on portfolios in environmental education also indicates that they provide a comprehensive representation of students' progress and achievements in various contexts and highlight the holistic and interdisciplinary nature of environmental education.

6. Expert evaluation method. In the expert evaluation method, a student's environmental competence is assessed by specialists, methodologists, practicing teachers, or academic supervisors based on specific criteria. This method is particularly important for identifying complex, multi-component competencies, as expert evaluation makes it possible to assess not only students' knowledge but also the quality of problem-solving, pedagogical approaches, the validity of practical decisions, and their professional preparedness. Studies on the project-based preparation of future teachers demonstrate that independent and qualified expert groups are involved to ensure the objective assessment of results, while competence levels are determined through a combination of surveys, observation, analysis of activity products, and expert evaluation. The Organisation for Economic Co-operation and Development also emphasizes the importance of combining evidence from multiple sources when assessing complex competencies; therefore, expert evaluation should be integrated with other assessment methods.

4. Conclusion

In conclusion, assessing the environmental competence of future natural science teachers requires the integrated application of various methods, such as testing, questionnaires, observation, project-based assessment, portfolio assessment, and expert evaluation. This is because environmental competence encompasses not only knowledge but also environmental values, practical skills, responsible behavior, and reflective preparedness. In this regard, the use of a comprehensive system of complementary assessment tools, rather than relying on a single method, provides more objective results. Such an approach not only enables the identification of the level of environmental competence among future teachers but also helps determine directions for its further development.

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