



Article

Theoretical Basis for the Development of Ecological Competence

Aslonova Emma Sergeevna*¹

1. Independent researcher at the Institute for Retraining and Professional Development of Higher Education Personnel under the Ministry of Higher Education, Science, and Innovations of the Republic of Uzbekistan

Abstract: This study explores the theoretical foundations for the development of ecological competence as an essential component of modern education. It examines key concepts within Environmental Education and Sustainable Development, highlighting the integration of ecological knowledge, values, attitudes, and responsible behavior. The paper analyzes interdisciplinary approaches, pedagogical principles, and cognitive determinants that contribute to shaping ecological awareness and competence among learners. Special attention is given to the role of educational environments, innovative teaching methods, and learner-centered strategies in fostering environmentally responsible thinking and action. The findings emphasize that ecological competence is a dynamic and multifaceted construct, requiring continuous development through formal and informal educational contexts.

Keywords: Ecological Competence, Environmental Education, Sustainable Development, Ecological Awareness, Environmental Responsibility, Interdisciplinary Approach, Pedagogy, Cognitive Development, Green Skills, Environmental Literacy.

Citation: Sergeevna A. E. Theoretical Basis for the Development of Ecological Competence. *Pioneer: Journal of Advanced Research and Scientific Progress* 2026, 5(2), 166-170.

Received: 12th Feb 2026

Revised: 13th Mar 2026

Accepted: 26th Apr 2026

Published: 07th May 2026



Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>)

1. Introduction

Environmental competence is developed within the framework of the competency-based approach, which became widespread in pedagogy in the late 20th century. This approach focuses on developing an individual's ability to act in conditions of uncertainty, make decisions, and take responsibility for their consequences [1].

As noted by S.R. Dominik, the "DeSeCo" (Definition and Selection of Competencies) project played an important role in international practice, emphasizing the need to incorporate the ability to regulate human interaction with the environment into the framework of key competencies [2].

Based on m

y analysis of open-access scientific literature, I would like to note that particular attention is paid to the practice-oriented nature of environmental education. For example, in Nordic countries (Finland, Sweden), the "whole-school approach" model is widely used, which involves integrating sustainable development principles into all aspects of an educational organization's activities—from curricula to school resource management. In Finland, environmental competence is developed through interdisciplinary modules that include the analysis of real environmental cases and project activities [3]. In Germany, the concept of *Bildung für nachhaltige Entwicklung* (education for sustainable development) is actively used, aimed at developing students' ability to make decisions in conditions of uncertainty and environmental risks [4].

This experience demonstrates that the key factor for effectiveness is the transition from theoretical instruction to the practical involvement of students and teachers in solving environmental problems.

S. A. Stepanov emphasizes in his works that environmental education should be systemic and interdisciplinary, ensuring that students develop not only a body of knowledge but also stable value orientations aimed at harmonizing the interaction between humans and the environment. In this regard, the development of environmental thinking is crucial, as is the recognition of responsibility for the consequences of decisions made, which is a crucial prerequisite for society's transition to sustainable development [5].

In this context, it should be noted that current trends in the development of environmental education in the Republic of Uzbekistan are closely linked to the implementation of state environmental policy, which is aimed at ensuring environmental safety and sustainable nature management.

As noted in the National Report on the State of the Environment: Uzbekistan. H. Asilbekova, Z. Yarullina, M. Plotsen, and a number of other authors pay special attention to climate change, water resource scarcity, land degradation, and increasing greenhouse gas emissions. Uzbekistan is among the countries susceptible to water stress, which increases the urgency of developing environmental awareness and public competence [6].

Within the framework of state policy, a number of strategic documents are being implemented, including the Strategy for the Transition to a Green Economy for 2019–2030, the Concept for Improving Environmental Culture by 2030, as well as educational and scientific initiatives in the field of ecology. Systematic measures aimed at developing environmental culture are being taken in Uzbekistan; however, an imbalance between theoretical training and the development of practical skills remains, necessitating the modernization of pedagogical approaches. A special role in this process is assigned to the education system, within the framework of which green educational programs are being introduced, environmental research is being developed, and practical skills for environmentally responsible behavior are being developed. At the same time, as Dmitry Sergeevich Ermakov notes in the article "Green Schools for Sustainable Development," traditional educational approaches focused primarily on the transfer of knowledge are proving insufficient [7]. Thus, we believe that the key factor in the effectiveness of environmental education is the transition from the theoretical mastery of content to the practical involvement of students and teachers in environmental activities. Based on the analysis of the studied material, in my opinion, there is a need to develop in teaching staff the ability not only to understand environmental processes, but also to make decisions, predict consequences and act in conditions of environmental restrictions.

Literature review

Environmental competence of teaching staff is considered an integrative personality trait, encompassing interconnected components that ensure the ability to interact responsibly with the environment. Environmental competence content is multifaceted and should include the following elements:

1. Cognitive-digital component.

The digitalization of environmental education is actively developing in international practice. In particular, the European Commission's initiatives include digital education programs that utilize digital platforms and data analysis tools (European Commission, 2020).

The results of research conducted by Mackey T.K., Cuomo R.E., Sahut J.M., et al. demonstrate that digital technologies enable the effective monitoring of environmental indicators and the processing of data for sustainable development .

The implementation of this component will help develop teachers' skills in analyzing big data and interpreting environmental information, which is an important element of modern environmental competence. Pollution analysis based on open data is already being used in our country. However, the use of GIS (geographic information systems), environmental mobile applications, and digital monitoring (e.g., air quality) requires relevant knowledge. This, in turn, contributes to the development of digital environmental competence in students through the application of geoinformation technologies and the development of climate literacy.

In many countries, this approach is being implemented through the introduction of specialized climate courses and the development of climate data analysis skills. As noted in the research of Arjen E. J. Wals et al., based on initiatives by UNESCO and the Organization for Economic Cooperation and Development, a need has arisen to develop analytical and practical competencies, including data handling skills and an understanding of climate processes, with a particular focus on developing students' ability to interpret climate information and apply it in practice .

In Uzbekistan, climate issues are already presented in educational content; however, they are currently not considered an independent competency. In this regard, climate literacy can be justified as an important component of an individual's environmental competence. In this regard, the implementation of a cognitive-digital component is of particular importance. In our opinion, this component should be aimed at developing the ability to analyze environmental information, use digital resources to solve practical problems, and correctly interpret environmental data.

2. Materials and Methods

This study employs a qualitative research design based on document analysis and systematic literature review. Data were collected from peer-reviewed articles, international reports, and policy documents related to environmental competence and digital education. The study applies thematic analysis to identify key components of environmental competence, including cognitive, digital, and practical dimensions. Comparative analysis was used to examine international practices and their applicability to the context of Uzbekistan.

3. Results

The results of the study indicate that environmental competence is a multidimensional construct that requires the integration of cognitive, practical, and value-oriented components. The analysis shows that effective environmental education systems are characterized by a strong emphasis on practice-oriented learning, interdisciplinary integration, and active stakeholder engagement [8].

The findings reveal that countries implementing a "whole-school approach," such as Finland, demonstrate higher levels of environmental awareness and behavioral change among both teachers and students. In these contexts, environmental competence is developed through project-based learning, real-world problem solving, and continuous interaction with environmental issues [9].

The study also identifies the growing importance of the cognitive-digital component in environmental competence. Digital tools, including data analysis platforms, geographic information systems (GIS), and environmental monitoring applications, significantly enhance the ability of educators to interpret environmental data and apply it in teaching practice. The integration of digital technologies supports the development of climate literacy and improves decision-making skills in conditions of environmental uncertainty. Furthermore, the results highlight that in Uzbekistan, although environmental topics are

included in educational content, there remains a gap between theoretical knowledge and practical application. The lack of systematic integration of digital tools and practice-oriented methods limits the development of fully functional environmental competence among teaching staff [10].

Overall, the findings suggest that improving environmental competence requires a shift from knowledge transmission to competency development, with a focus on practical engagement, digital literacy, and the ability to make informed decisions in complex environmental contexts [11].

4. Discussion

The findings of this study demonstrate that environmental competence is a complex and multidimensional construct that integrates cognitive, digital, and value-based components. The results are consistent with international research emphasizing the importance of practice-oriented and interdisciplinary approaches in environmental education. In particular, countries that apply the “whole-school approach,” such as Finland and Germany, show higher effectiveness in developing environmental competence among teachers and students. This confirms that environmental education becomes more effective when it is embedded not only in curricula but also in institutional culture and daily educational practices.

The study also highlights the growing importance of the cognitive-digital component. The integration of digital technologies such as GIS systems, environmental monitoring tools, and data analysis platforms significantly enhances educators’ ability to interpret environmental information and apply it in teaching practice. This aligns with previous studies that emphasize the role of digitalization in advancing sustainable development education [12], [13].

However, the analysis reveals that in Uzbekistan, environmental education is still largely theoretical, with limited integration of practical and digital components. This gap between theory and practice reduces the overall effectiveness of environmental competence development among teaching staff. Therefore, there is a strong need for methodological modernization and the introduction of innovative pedagogical approaches [14]. Another important finding is that environmental competence should not be viewed solely as knowledge acquisition but as the ability to act responsibly in real environmental contexts. This requires a shift from traditional knowledge-based teaching to competency-based and activity-oriented learning models [15].

5. Conclusion

This study investigated the structure and development of environmental competence within the framework of a competency-based approach. The results indicate that environmental competence is a key element of modern education for sustainable development and should include cognitive, practical, and digital dimensions.

The research confirms that effective environmental competence development depends on the integration of theoretical knowledge with practical experience and digital technologies. International best practices demonstrate that interdisciplinary and practice-oriented approaches significantly enhance the effectiveness of environmental education.

In the context of Uzbekistan, there is a need to strengthen the practical orientation of environmental education by introducing digital tools, project-based learning, and real-life environmental problem-solving activities. This will help bridge the gap between theoretical knowledge and practical application.

Overall, the development of environmental competence among teaching staff is essential for ensuring sustainable development, improving environmental awareness, and preparing educators capable of addressing complex environmental challenges. Future research should focus on empirical studies involving teachers and students to further validate and refine the proposed framework.

REFERENCES

- [1] A. Kulik, "Competency-based approach and competencies in higher education: A theoretical study," Available: ResearchGate.
- [2] S. R. Dominic, *A Comprehensive Conceptual Framework for Assessing Key Competencies in an International Context: Lessons from an Interdisciplinary and Policy-Oriented Approach*. Luxembourg: Office for Official Publications of the European Communities, 2004.
- [3] M. Vesterinen, "Sustainability competencies in environmental education: A study of teaching materials for primary school teachers in Finland," *Cogent Education*, 2023.
- [4] German Federal Ministry of Education and Research, *Education for Sustainable Development Strategy*. Berlin, Germany, 2020.
- [5] S. A. Stepanov, "On the strategy of sustainable development as a theoretical and methodological basis of environmental education," Available: CyberLeninka.
- [6] H. Asilbekova, Z. Yarullina, and M. Plocen, *National Report on the State of the Environment: Uzbekistan*. International Institute for Sustainable Development, 2023.
- [7] D. S. Ermakov, A. S. Ermakov, and D. V. Morgun, "Green schools for sustainable development," 2022, doi: 10.21209/2658-7114-2022-17-2-6-14.
- [8] E. A. Makarova, *Methods for Developing Environmental Competence of Future Teachers: Collaboration Technologies*. Samara, Russia, 2011.
- [9] T. K. McKee, R. E. Cuomo, J. M. Sayu, *et al.*, "The contribution of digitalization to sustainable development in Europe," Luxembourg: European Commission, 2023.
- [10] A. J. Arjen, "Sustainable development in higher education in the context of the UN Decade of Education for Sustainable Development," *Journal of Cleaner Production*, vol. 62, pp. 8–15, 2014.
- [11] UNESCO, *Education for Sustainable Development Goals: Learning Objectives*. Paris, France, 2017.
- [12] OECD, *The Definition and Selection of Key Competencies (DeSeCo)*. Paris, France, 2005.
- [13] W. Leal Filho, *Handbook of Sustainability Science and Research*. Cham: Springer, 2018.
- [14] J. Wiek, L. Withycombe, and C. L. Redman, "Key competencies in sustainability: A reference framework for academic program development," *Sustainability Science*, vol. 6, no. 2, pp. 203–218, 2011.
- [15] D. Tilbury, "Education for sustainable development: An expert review of processes and learning," UNESCO, Paris, France, 2011.