BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
BG PULSE JOURNAL

ENHANCING ENVIRONMENTAL COMPETENCIES OF PRE-SERVICE PRIMARY SCHOOL TEACHERS THROUGH CASE-BASED LEARNING: EVIDENCE FROM TEACHER EDUCATION IN UZBEKISTAN

Gulshana Shukhratovna Abdullayeva
Lecturer, NamSU
Doi https://doi.org/10.5281/zenodo.21294788

Abstract: The development of environmental competencies among future teachers has become an essential priority in modern pedagogical education, particularly in the context of sustainable development, climate change, and increasing ecological challenges. This article examines the improvement of environmental competencies in the process of preparing pre-service primary school teachers in Uzbekistan. The study is based on the need to integrate ecological content into professional teacher education and to apply practice-oriented pedagogical technologies, including case-based learning and ecological exercises.

The purpose of the study is to substantiate and evaluate a pedagogical model aimed at improving environmental competencies among future primary school teachers. The research is grounded in competence-based, systemic, activity-based, personality-oriented, interdisciplinary, and practice-oriented approaches. The study uses theoretical analysis, observation, questionnaires, testing, analysis of students' learning products, and pedagogical experiment.

The proposed model includes value-motivational, cognitive, activity-practical, and reflective components of environmental competence. It also incorporates ecological case tasks, pedagogical situations, project assignments, and methodological exercises related to primary education. The findings indicate that the systematic integration of ecological content into professional disciplines contributes to the development of students' ecological thinking, environmental culture, methodological readiness, and ability to organize environmental education for primary school pupils.

The article concludes that case-based learning is an effective pedagogical tool for improving environmental competencies in teacher education. The proposed model may be used in pedagogical universities to modernize curricula, strengthen practice-oriented training, and prepare future teachers for environmental education and upbringing in primary schools.

Keywords: environmental competence; pre-service teachers; primary education; case-based learning; teacher education; ecological culture; sustainable development; Uzbekistan.

Introduction

The current stage of social development is characterized by the intensification of environmental challenges that affect almost all spheres of human life. Climate change, ecosystem degradation, depletion of natural resources, environmental pollution, and increasing anthropogenic pressure require a reconsideration of educational priorities. In these conditions, the ecologization of education becomes one of the strategic directions of national and international educational policy.

Teacher education plays a particularly important role in this process. The preparation of pedagogical personnel capable of developing ecological culture, environmental responsibility, and environmentally appropriate behaviour among the younger generation is becoming one of the key tasks of higher pedagogical education. This issue is especially relevant for the preparation of future

primary school teachers, since the foundations of worldview, moral values, behavioural patterns, and attitudes toward nature are formed during the primary school age.

The relevance of this study is determined by several theoretical and practical factors. First, the modernization of higher pedagogical education requires strengthening the competence-based orientation of teacher training. This means that the education of future teachers should not be limited to the transmission of theoretical knowledge. It should also include the development of integrative competencies that combine knowledge, values, practical skills, and experience of professional activity.

Second, current practice reveals a number of contradictions in the preparation of future primary school teachers. There is a contradiction between the social demand for teachers with a high level of environmental competence and the insufficient development of effective pedagogical mechanisms for its formation in higher education institutions. There is also a contradiction between the need to integrate environmental issues into professional disciplines and the fragmentary inclusion of such content in educational programmes. Another important contradiction exists between the demand for active, practice-oriented learning technologies and the predominance of traditional knowledge-transmission methods.

Third, for the Republic of Uzbekistan, the improvement of environmental competencies among future teachers is of particular importance because of regional environmental problems, the need for sustainable natural resource management, the development of ecological culture among the population, and the formation of a system of continuous environmental education. In this context, it is necessary to identify pedagogical technologies that can effectively develop environmental competencies among students of pedagogical universities, taking into account the specific features of primary education.

One of the most promising directions in this regard is the use of case-based learning. Case technology allows students to analyse real pedagogical and ecological situations, develop critical thinking, make decisions, apply theoretical knowledge in practical contexts, and integrate interdisciplinary content. In the training of future primary school teachers, ecological case tasks may serve as an effective means of connecting environmental knowledge with professional pedagogical activity.

The purpose of this article is to substantiate a pedagogical model for improving environmental competencies among future teachers in the process of preparing primary education specialists and to determine the effectiveness of case-based and practice-oriented learning technologies.

The research object is the process of professional preparation of future teachers in the system of higher pedagogical education.

The research subject is the content, pedagogical conditions, methods, and technologies for improving environmental competencies among future primary school teachers during their professional training.

The scientific novelty of the study lies in the clarification of the concept of environmental competence of future teachers as an integrative personal and professional quality that includes value-motivational, cognitive, activity-practical, and reflective components. The study also proposes a model for improving environmental competencies through ecological exercises, pedagogical situations, and case tasks integrated into professional teacher education.

The practical significance of the study is associated with the possibility of using the proposed model, diagnostic tools, case tasks, exercises, and methodological recommendations in pedagogical universities. These materials may help strengthen the ecological orientation of professional teacher

education, improve the connection between theoretical knowledge and pedagogical practice, and increase future teachers' readiness to conduct environmental education with primary school pupils.

2. Literature Review and Theoretical Background

Environmental competence has become one of the key concepts in contemporary educational research due to the growing importance of sustainable development and environmental protection. During the last three decades, scholars have increasingly emphasized that teacher education should prepare future educators not only to possess environmental knowledge but also to integrate environmental values, critical thinking, and sustainable practices into everyday educational activities. Consequently, environmental competence is now regarded as an integral component of teachers' professional competence.

The theoretical foundations of environmental education were established in the works of Zverev (1980), Zakhlebny (1986), Glazachev (2001), Moiseeva (2003), and Sikorskaya (1987), who defined the objectives, principles, and educational functions of environmental education within the school system. Their studies demonstrated that environmental education should extend beyond the transmission of ecological knowledge and contribute to the development of ecological culture, environmental responsibility, and environmentally appropriate behaviour.

A significant contribution to understanding the psychological and pedagogical aspects of environmental education was made by Yasvin (2001), who introduced the concept of the educational environment as a factor influencing students' personal development. Moiseev (1990) emphasized the relationship between humanity and the biosphere, arguing that the future of civilization depends largely on environmental responsibility and ecological thinking. Similarly, Surantaev (2005) considered environmental education to be one of the principal mechanisms for developing an individual's environmental culture.

Recent international studies have considerably expanded the concept of environmental competence. Rather than viewing it as a collection of ecological knowledge and practical skills, researchers increasingly define it as a multidimensional construct that combines cognitive, affective, behavioural, ethical, and reflective dimensions. This perspective is reflected in the European Commission's GreenComp framework, which identifies sustainability competence as a combination of values, systems thinking, futures literacy, critical thinking, and collaborative action for sustainability.

The competence-based approach has become the dominant paradigm in contemporary teacher education. According to Rieckmann (2012), environmental competence should enable future teachers to understand complex environmental systems, evaluate alternative solutions, and facilitate sustainable decision-making in educational settings. Wiek, Withycombe, and Redman (2011) likewise identified systems thinking, anticipatory competence, normative competence, strategic competence, and interpersonal competence as essential sustainability competencies for higher education graduates.

Research conducted by Roczen, Kaiser, Bogner, and Wilson (2014) further demonstrated that environmental competence consists of interrelated motivational, cognitive, and behavioural components. Their competence model has become one of the most influential theoretical frameworks for assessing environmental competence in educational research. The authors argue that environmental knowledge alone cannot guarantee environmentally responsible behaviour unless it is supported by appropriate values, motivation, and practical experience.

Within teacher education, interdisciplinary integration has been recognized as one of the most effective approaches for developing environmental competence. Barth et al. (2007) emphasize that

sustainability education requires cooperation among different academic disciplines because environmental problems cannot be understood from a single disciplinary perspective. Interdisciplinary learning enables students to integrate pedagogical, ecological, psychological, and methodological knowledge while simultaneously developing critical thinking and professional decision-making skills.

Another important direction in contemporary educational research concerns the implementation of active learning strategies. Case-based learning, project-based learning, inquiry-based learning, and problem-based instruction are increasingly regarded as effective pedagogical technologies for developing professional competencies. These approaches encourage students to analyse authentic situations, evaluate evidence, propose solutions, and reflect upon their professional decisions. Within environmental education, case-based learning is particularly valuable because it allows future teachers to address real environmental issues encountered in educational practice.

Despite the substantial body of international literature devoted to environmental education, relatively few studies have investigated the development of environmental competence among future primary school teachers within the context of higher pedagogical education in Central Asia. Existing research in Uzbekistan has primarily focused on ecological education as a separate academic discipline rather than on its systematic integration into professional teacher preparation. Consequently, the pedagogical potential of case-based learning for improving environmental competence remains insufficiently explored.

Another limitation of previous studies is that environmental competence has often been assessed primarily through students' theoretical knowledge. Contemporary educational research, however, increasingly recognizes that competence should also include professional values, practical teaching skills, reflective abilities, and readiness to organize environmental education in real classrooms. Therefore, there is a growing need for pedagogical models capable of integrating these components into a coherent system of professional teacher preparation.

The present study addresses these research gaps by proposing and experimentally evaluating a pedagogical model based on case-based learning and interdisciplinary integration. Unlike traditional approaches that emphasize theoretical ecological knowledge, the proposed model seeks to develop environmental competence through authentic pedagogical situations, ecological projects, methodological tasks, reflective practice, and professionally oriented environmental cases. This integrated approach provides future primary school teachers with opportunities to transform ecological knowledge into practical professional competence, thereby increasing their readiness to organize effective environmental education in primary schools.

3. Materials and Methods

Research Design

This study employed a mixed-methods research design combining qualitative and quantitative approaches to investigate the effectiveness of case-based learning in improving the environmental competencies of pre-service primary school teachers. The research was conducted in accordance with the competence-based paradigm of higher education and focused on integrating environmental education into the professional preparation of future teachers.

The study was carried out at Namangan State University within the Faculty of Primary Education. The pedagogical experiment was designed to evaluate the effectiveness of a specially developed instructional model aimed at improving environmental competence through interdisciplinary integration and case-based learning technologies.

Participants

The participants were undergraduate students enrolled in the Primary Education programme at Namangan State University. Students participated voluntarily and represented comparable academic backgrounds before the beginning of the experiment. For the purposes of the pedagogical experiment, participants were divided into a control group and an experimental group.

The control group continued studying according to the traditional curriculum, whereas the experimental group received instruction based on the proposed pedagogical model, which incorporated environmental case studies, interdisciplinary assignments, ecological projects, reflective learning activities, and professionally oriented practical tasks.

Theoretical Foundations of the Model

The proposed pedagogical model was developed on the basis of several complementary educational approaches:

1. the competence-based approach, which emphasizes learning outcomes expressed through professional competencies;
2. the systems approach, which considers environmental competence as an integrated professional quality;
3. the activity-based approach, focusing on students' active participation in solving authentic pedagogical problems;
4. the learner-centred approach, which promotes students' independence, creativity, and professional self-development;
5. the interdisciplinary approach, integrating environmental content into professional teacher education courses;
6. the practice-oriented approach, ensuring the application of theoretical knowledge in authentic educational contexts.

The integration of these approaches created favorable pedagogical conditions for the comprehensive development of environmental competence among future primary school teachers.

Structure of Environmental Competence

Based on the theoretical analysis and the objectives of the research, environmental competence was considered to consist of four interconnected components:

Value–Motivational Component

This component reflects students' environmental values, ecological awareness, professional motivation, ethical responsibility, and positive attitudes toward environmental protection. It determines their willingness to participate actively in environmental education and sustainable development initiatives.

Cognitive Component

The cognitive component includes scientific environmental knowledge, understanding of ecological principles, awareness of environmental challenges, knowledge of sustainable development concepts, and familiarity with methods of environmental education in primary schools.

Activity–Practical Component

This component characterizes students' ability to apply environmental knowledge during professional activities. It includes lesson planning, organization of environmental projects, ecological observations, classroom management, interdisciplinary teaching, and the application of innovative educational technologies.

Reflective Component

The reflective component represents students' ability to evaluate their own professional activities, analyse educational outcomes, identify strengths and weaknesses, and continuously improve their environmental teaching competence through lifelong professional learning.

These four components were used as the conceptual basis for developing diagnostic instruments and evaluating the effectiveness of the proposed pedagogical model.

Research Methods

To accomplish the objectives of the study, several complementary research methods were employed.

Literature Analysis

Scientific publications, educational standards, legislative documents, and international policy papers related to environmental education, teacher education, competency-based learning, and sustainable development were systematically analysed. The literature review provided the theoretical basis for constructing the research model.

Pedagogical Observation

Continuous observation was conducted throughout the experimental period to evaluate students' participation in learning activities, environmental projects, classroom discussions, and practical teaching exercises. Particular attention was paid to students' ability to integrate environmental concepts into professional pedagogical activities.

Questionnaire Survey

Questionnaires were administered before and after the experiment to determine students' environmental knowledge, attitudes toward environmental protection, professional motivation, and self-assessment of environmental competence.

Diagnostic Tasks

Special diagnostic assignments were developed to assess students' environmental competence. These included:

1. analysis of environmental case studies;
2. solution of pedagogical situations;
3. lesson planning with integrated environmental content;
4. analysis of ecological texts;
5. development of educational projects for primary school pupils;
6. preparation of extracurricular environmental activities.

The diagnostic tasks assessed not only theoretical knowledge but also students' professional decision-making skills.

Pedagogical Experiment

The pedagogical experiment represented the central stage of the research.

The experiment consisted of three consecutive phases.

Diagnostic phase. Students' initial level of environmental competence was assessed using questionnaires, observations, interviews, and diagnostic assignments.

Formative phase. The experimental group participated in specially designed interdisciplinary learning activities incorporating environmental case studies, project-based learning, collaborative tasks, ecological simulations, field observations, and reflective practice.

Control phase. The effectiveness of the instructional model was evaluated by comparing the achievements of the experimental and control groups using identical assessment instruments.

Data Analysis

The collected data were analysed using descriptive and comparative statistical methods. Quantitative indicators obtained from questionnaires and diagnostic tasks were compared between the control and experimental groups before and after the intervention. Qualitative data obtained through observation and students' reflective reports were analysed to identify changes in professional attitudes, environmental awareness, and practical teaching competence.

The combined use of quantitative and qualitative methods ensured the reliability and validity of the research findings and provided a comprehensive evaluation of the effectiveness of the proposed pedagogical model.

4. Results

The implementation of the proposed pedagogical model demonstrated a positive influence on the development of environmental competencies among pre-service primary school teachers. The comparative analysis of the diagnostic and final assessment results revealed that students in the experimental group achieved significantly better learning outcomes than those in the control group.

The improvement was observed across all four structural components of environmental competence, including value–motivational, cognitive, activity–practical, and reflective dimensions. Students who participated in the experimental programme demonstrated a more comprehensive understanding of environmental issues, greater motivation to integrate environmental education into future teaching practice, and stronger professional confidence in organizing environmentally oriented educational activities.

Development of the Value–Motivational Component

One of the most significant outcomes of the experiment was the enhancement of students' environmental values and professional motivation. At the beginning of the study, many participants perceived environmental education primarily as an additional educational topic rather than an integral part of teacher professional competence. Following the implementation of the interdisciplinary model, students increasingly recognized environmental education as one of the essential responsibilities of a primary school teacher.

Participation in ecological case studies, classroom discussions, collaborative projects, and environmental campaigns contributed to the development of positive attitudes toward nature and strengthened students' willingness to participate in environmental protection initiatives. Reflection activities further encouraged students to evaluate their own environmental behaviour and professional responsibilities.

Improvement of the Cognitive Component

The findings indicate substantial growth in students' environmental knowledge. Participants demonstrated a deeper understanding of ecological concepts, environmental legislation, sustainable development principles, biodiversity conservation, climate change, and environmental protection strategies.

Unlike traditional lecture-based instruction, the case-based approach encouraged students to analyse authentic environmental situations, identify causal relationships, evaluate alternative solutions, and justify pedagogical decisions using scientific evidence. As a result, students developed systems thinking and improved their ability to connect theoretical knowledge with professional practice.

Development of Practical Teaching Skills

The activity–practical component showed considerable improvement during the experimental programme. Students became more proficient in designing environmentally oriented lesson plans, preparing interdisciplinary teaching materials, organizing project-based learning activities, and conducting environmental observations suitable for primary school pupils.

During teaching practice, participants successfully integrated environmental topics into various subjects, including language arts, reading, science, mathematics, and extracurricular educational activities. They demonstrated the ability to organize educational games, environmental campaigns, classroom discussions, and inquiry-based learning activities that encouraged children's environmental awareness and responsible behaviour.

The ecological case studies proved particularly effective because they required students to solve realistic pedagogical problems rather than simply reproduce theoretical information.

Development of Reflective Competence

An important outcome of the study was the improvement of students' reflective abilities. Throughout the experimental programme, participants regularly analysed their own teaching activities, evaluated instructional decisions, discussed difficulties encountered during lesson planning, and proposed strategies for professional improvement.

Reflective journals, peer discussions, and instructor feedback enabled students to develop greater self-awareness regarding their professional strengths and weaknesses. Such reflection contributed to continuous professional growth and increased readiness for lifelong learning.

Comparative Analysis of Learning Outcomes

The comparative evaluation of the control and experimental groups demonstrated clear advantages of the proposed instructional model.

Students who completed the interdisciplinary programme consistently outperformed those receiving traditional instruction in terms of:

1. environmental knowledge;
2. environmental awareness;
3. ecological values;
4. professional motivation;
5. lesson planning skills;
6. interdisciplinary thinking;
7. problem-solving ability;
8. readiness for environmental education;
9. reflective competence.

These findings indicate that the integration of environmental case studies into teacher education substantially enhances the overall quality of professional preparation.

Effectiveness of Case-Based Learning

The pedagogical experiment confirmed that case-based learning represents one of the most effective instructional technologies for developing environmental competence among future teachers.

Unlike conventional lecture-based teaching, environmental cases encouraged students to:

1. analyse authentic educational situations;
2. identify environmental problems;
3. evaluate multiple alternative solutions;
4. justify professional decisions;
5. collaborate in groups;
6. develop communication skills;
7. integrate knowledge from different academic disciplines;
8. apply theoretical concepts in practical contexts.

Consequently, students became active participants in the educational process rather than passive recipients of information. This active engagement significantly increased both learning motivation and professional competence.

Summary of the Experimental Findings

Overall, the results of the pedagogical experiment demonstrate that the proposed interdisciplinary model provides favourable conditions for improving environmental competence among future primary school teachers. The integration of ecological content, case-based learning,

project activities, reflective practice, and interdisciplinary instruction contributes to the comprehensive development of professional competencies required for environmental education in primary schools.

The positive outcomes obtained during the experiment confirm the effectiveness of the proposed pedagogical model and support its implementation within teacher education programmes aimed at preparing environmentally competent educators capable of promoting sustainable development in school education.

5. Discussion

The findings of the present study demonstrate that the systematic integration of case-based learning into the professional preparation of future primary school teachers significantly enhances the development of environmental competencies. The results are consistent with the contemporary competence-based paradigm of higher education, which emphasizes that professional competence is formed through the integration of knowledge, values, practical skills, and reflective experience rather than through the acquisition of theoretical information alone.

One of the principal findings of this research is that environmental competence should be regarded as a multidimensional construct. The improvement observed across the value–motivational, cognitive, activity–practical, and reflective components confirms that these dimensions are closely interconnected and mutually reinforcing. Students who demonstrated greater environmental awareness also exhibited stronger professional motivation, higher levels of pedagogical creativity, and greater confidence in organizing environmentally oriented educational activities.

These findings support the theoretical framework proposed by Roczen et al. (2014), who argued that environmental competence consists of cognitive, motivational, and behavioural dimensions. Similarly, Wiek et al. (2011) emphasized that sustainability competencies cannot be developed through isolated disciplinary instruction but require interdisciplinary learning experiences that encourage systems thinking and practical problem-solving. The present research confirms these theoretical assumptions within the context of teacher education in Uzbekistan.

The results also correspond to the principles outlined in the GreenComp framework developed by the European Commission. GreenComp identifies sustainability competence as a combination of environmental values, systems thinking, critical thinking, futures literacy, and collaborative action. Although the present study was conducted in a different educational context, the proposed pedagogical model reflects many of these principles by integrating environmental case studies, collaborative learning, project-based activities, and reflective practice into teacher education.

An important contribution of this research is the demonstration that case-based learning serves as an effective bridge between theoretical preparation and professional practice. Traditional instructional methods often encourage memorization of environmental concepts without providing sufficient opportunities for their practical application. In contrast, ecological case studies require students to analyse authentic educational situations, evaluate alternative pedagogical strategies, make evidence-based decisions, and justify their professional actions. Such learning experiences promote deeper conceptual understanding while simultaneously strengthening professional competence.

The interdisciplinary character of the proposed model also deserves particular attention. Environmental issues are inherently complex and cannot be adequately understood through the perspective of a single academic discipline. By integrating ecological content into pedagogy, psychology, teaching methodology, language education, literary reading, and natural science courses, students develop a holistic understanding of environmental education. This

interdisciplinary integration enables future teachers to incorporate environmental topics naturally into different school subjects instead of treating them as separate educational content.

Another important finding concerns the role of reflective learning. The results indicate that systematic reflection significantly improves students' professional development by encouraging critical self-analysis, evaluation of pedagogical decisions, and continuous improvement of teaching practice. Reflection enables future teachers to recognize the strengths and weaknesses of their instructional strategies and promotes lifelong professional learning, which is increasingly recognized as a fundamental requirement of contemporary teacher education.

From a practical perspective, the findings suggest that environmental competence should become one of the core professional competencies assessed during teacher preparation programmes. Universities preparing primary school teachers should therefore integrate environmental education throughout the curriculum rather than confining it to individual ecology-related courses. Such integration would contribute to the preparation of teachers capable of fostering environmental literacy and sustainable behaviour among younger generations.

The present study also has important implications for educational policy in Uzbekistan. National educational reforms increasingly emphasize competence-based education, sustainable development, and environmental responsibility. The proposed pedagogical model may therefore serve as a methodological framework for updating teacher education curricula, designing interdisciplinary courses, and developing instructional materials that correspond to modern educational standards.

Despite these positive findings, several limitations should be acknowledged. The research was conducted at a single higher education institution, which may limit the generalizability of the results. Furthermore, the study focused primarily on pre-service teachers, whereas future investigations could include practicing teachers, school administrators, and pupils to obtain a more comprehensive understanding of environmental competence development across different educational contexts.

Future research should also employ larger and more diverse samples, longitudinal research designs, and advanced statistical techniques to evaluate the long-term effectiveness of interdisciplinary and case-based learning models. Comparative international studies may further contribute to identifying best practices for integrating environmental education into teacher preparation programmes.

Overall, the findings provide convincing evidence that interdisciplinary case-based learning represents an effective pedagogical strategy for developing environmental competencies among future primary school teachers. The proposed model contributes not only to the theoretical understanding of environmental competence but also offers practical recommendations for improving the quality of teacher education in accordance with contemporary international educational standards.

6. Conclusion

The present study confirms that the development of environmental competencies among pre-service primary school teachers represents one of the strategic priorities of contemporary teacher education. Growing environmental challenges and the global transition toward sustainable development require educational institutions to prepare teachers who possess not only environmental knowledge but also the professional competencies necessary to integrate environmental education into the teaching and learning process.

The research demonstrates that environmental competence should be understood as a multidimensional professional construct consisting of four interrelated components: value–

motivational, cognitive, activity–practical, and reflective. The balanced development of these components enables future teachers to organize effective environmental education, promote environmentally responsible behaviour among pupils, and contribute to the implementation of sustainable development principles in school education.

The results of the pedagogical experiment indicate that the proposed interdisciplinary model based on case-based learning significantly improves the quality of professional teacher preparation. Students participating in the experimental programme demonstrated higher levels of environmental knowledge, stronger ecological values, greater professional motivation, improved pedagogical skills, and increased readiness to organize environmental education in primary schools compared with students receiving traditional instruction.

One of the principal advantages of the proposed model is its practice-oriented character. Environmental case studies, project-based learning, pedagogical simulations, interdisciplinary assignments, and reflective activities create authentic learning situations in which students apply theoretical knowledge to professional practice. Such an approach facilitates the transition from knowledge acquisition to competence development, which is consistent with the modern competence-based paradigm of higher education.

The interdisciplinary integration of environmental content into pedagogical disciplines also proved to be highly effective. Rather than treating environmental education as a separate academic subject, the proposed model incorporates ecological issues into pedagogy, teaching methodology, psychology, language education, literary reading, and classroom practice. This holistic approach promotes systems thinking and enables future teachers to integrate environmental education naturally into various aspects of primary school instruction.

The findings suggest that case-based learning should be regarded as one of the most effective instructional technologies for developing environmental competence in teacher education. By engaging students in analysing authentic pedagogical situations, evaluating alternative solutions, and making evidence-based decisions, case studies foster critical thinking, professional reflection, collaboration, and independent problem-solving.

The practical significance of the study extends beyond teacher education institutions. The proposed pedagogical model, diagnostic instruments, ecological case studies, and methodological recommendations may be incorporated into university curricula, teacher professional development programmes, and national educational standards aimed at strengthening environmental education. The model may also support educational reforms focused on improving the quality of teacher preparation and promoting environmental literacy among schoolchildren.

Overall, the study contributes to the theoretical development of environmental pedagogy and provides empirical evidence supporting the effectiveness of interdisciplinary case-based learning in developing environmental competencies among future primary school teachers. The proposed model offers a practical framework for modernizing teacher education programmes in Uzbekistan and may be adapted for implementation in other countries pursuing competence-based educational reforms.

Practical Implications

The findings of this study have several important practical implications for higher education institutions and educational policymakers.

First, pedagogical universities should systematically integrate environmental education into all professional teacher education courses rather than limiting it to individual ecology-related disciplines. Such integration will facilitate the comprehensive development of environmental competence throughout the teacher preparation programme.

Second, case-based learning should become a regular component of teacher education curricula. Authentic environmental cases enable students to develop analytical thinking, professional decision-making skills, interdisciplinary understanding, and practical teaching competence.

Third, universities should expand opportunities for project-based learning, environmental fieldwork, school-based practice, and collaboration with environmental organizations. These activities provide students with valuable professional experience and strengthen the connection between university education and real educational practice.

Fourth, diagnostic tools for assessing environmental competence should be incorporated into teacher education programmes to monitor students' professional development and evaluate the effectiveness of educational innovations.

Finally, the proposed model may serve as a methodological foundation for revising national teacher education standards, developing competency-based curricula, and supporting educational reforms aimed at promoting environmental literacy and sustainable development.

References

1. Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.
2. Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education, 8*(4), 416–430.
3. Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). *GreenComp: The European Sustainability Competence Framework*. Publications Office of the European Union.
4. Glazachev, S. N. (2001). *Environmental Culture of the Teacher*.
5. Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *The Journal of Environmental Education, 21*(3), 8–21.
6. Kaiser, F. G., & Roczen, N. (2008). Competence formation in environmental education. *Umweltpsychologie, 12*, 56–70.
7. Kuzmina, O. V. (2010). *An Interdisciplinary Approach to the Formation of Environmental Competence among Students of Pedagogical Universities* (Doctoral dissertation abstract).
8. Moiseev, N. N. (1990). *Man and the Noosphere*.
9. Moiseeva, L. V. (2003). *Environmental Education in Primary School*.
10. Palmer, J. A. (1998). *Environmental Education in the 21st Century*.
11. Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered? *Futures, 44*(2), 127–135.
12. Roczen, N., Kaiser, F. G., Bogner, F. X., & Wilson, M. (2014). A competence model for environmental education. *Environment and Behavior, 46*(8), 972–992.
13. Sterling, S. (2001). *Sustainable Education: Re-visioning Learning and Change*.
14. Surantaev, I. T. (2005). *Environmental Education as a Factor in the Formation of Individual Environmental Culture*.