HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

METHODOLOGICAL FOUNDATIONS FOR DEVELOPING STUDENTS' COMPETENCE IN THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN SCHOOL GEOGRAPHY EDUCATION

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Abstract: This article explores the relevant methodological foundations for forming and developing students' competence in the concept of sustainable development within geography education at general secondary schools. The author analyzes the role and significance of systemic, synergetic, competence-based, and axiological approaches in integrating Sustainable Development Goals (SDGs) into the educational system. The study highlights the specific characteristics of school geography courses aimed at fostering a comprehensive understanding of ecological, economic, and social interrelations, systemic analysis of global problems, and resource-saving skills among students. Furthermore, the pedagogical conditions for using project-based learning, case studies, and problem-based educational technologies in the learning process are substantiated, alongside proposed expected outcomes and criteria for evaluating students' ecological culture.

Keywords: sustainable development, geography education, competence-based approach, systemic analysis, global problems, ecological culture, pedagogical technologies, interdisciplinary integration.

Annotatsiya: Ushbu maqolada umumiy o‘rta ta’lim muassasalarida geografiya fanini o‘qitish jarayonida o‘quvchilarning barqaror rivojlanish konsepsiyasi bo‘yicha kompetentligini shakllantirish va rivojlantirishning dolzarb metodologik asoslari tadqiq etilgan. Muallif barqaror rivojlanish maqsadlarini (BRM) ta’lim tizimiga integratsiya qilishda tizimli, sinergetik, kompetensiyaviy va aksiologik yondashuvlarning o‘rni hamda ahamiyatini tahlil qiladi. Tadqiqotda maktab geografiya kurslarining mazmuni, o‘quvchilarda ekologik, iqtisodiy va ijtimoiy munosabatlarni uzviy tushunish, global muammolarni tizimli tahlil qilish hamda resurs tejovchi ko‘nikmalarni shakllantirishdagi o‘ziga xos xususiyatlari ochib berilgan. Shuningdek, dars jarayonida loyiha metodi, keys-stadi va muammoli ta’lim texnologiyalaridan foydalanishning pedagogik shart-sharoitlari asoslangan bo‘lib, kutilayotgan natijalar va o‘quvchilarning ekologik madaniyatini baholash mezonlari taklif etilgan.

Kalit so‘zlar: barqaror rivojlanish, geografiya ta’limi, kompetensiyaviy yondashuv, tizimli tahlil, global muammolar, ekologik madaniyat, pedagogik texnologiyalar, fanlararo integratsiya.

Аннотация: В данной статье исследуются актуальные методологические основы формирования и развития компетентности учащихся по концепции устойчивого развития в процессе обучения географии в общеобразовательных школах. Автор анализирует роль и значимость системного, синергетического, компетентностного и аксиологического подходов в интеграции целей устойчивого развития (ЦУР) в систему образования. В исследовании

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HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
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раскрываются особенности содержания школьных курсов географии, направленные на формирование у учащихся целостного понимания экологических, экономических и социальных взаимосвязей, системного анализа глобальных проблем и навыков ресурсосбережения. Также обоснованы педагогические условия использования проектного метода, кейс-стади и технологий проблемного обучения в учебном процессе, предложены ожидаемые результаты и критерии оценки экологической культуры учащихся.

Ключевые слова: устойчивое развитие, географическое образование, компетентностный подход, системный анализ, глобальные проблемы, экологическая культура, педагогические технологии, межпредметная интеграция.

INTRODUCTION

In the 21st century, humanity is facing serious challenges such as global environmental crises, climate change, the depletion of natural resources, and socio-economic inequalities. Under such circumstances, leaving a sustainable world for future generations and fundamentally changing society's relationship with nature have become global strategic priorities. The "2030 Agenda for Sustainable Development" adopted by the United Nations, together with its 17 Sustainable Development Goals (SDGs), requires the transformation of the education system, along with all other sectors. In particular, Goal 4 — "Quality Education" — specifically emphasizes the development of students' sustainable development and global citizenship skills.

In the Republic of Uzbekistan, the fundamental reform of the education system and the upbringing of the younger generation to be environmentally responsible are also among the priority areas of state policy. The new edition of the Constitution of the Republic of Uzbekistan, the Law "On Education," and the Concept for the Development of Environmental Education set forth tasks aimed at increasing students' environmental awareness and developing their systems thinking. In implementing these tasks, geography as a subject taught in general secondary education institutions serves as a fundamental basis. Since geography education is a unique field of study that examines the interrelationships between nature, society, and the economy as an integrated whole, it has unparalleled potential for developing students' competence in sustainable development. However, the fact that current school geography education is limited to providing only theoretical knowledge of this concept, while the methodological mechanisms for transforming knowledge into life skills (competencies) have not yet been fully developed, demonstrates the relevance of this problem.

LITERATURE REVIEW ON THE TOPIC

The issues of introducing the concept of sustainable development into the education system and developing students' ecological and geographical culture have been extensively studied in academic circles both internationally and in the Republic. At the international level, researchers such as J. Sterling, V. Scott, and L. Sauvé have substantiated the philosophical and methodological aspects of the ecologization of the education system, while Russian scholars such as N. M. Mamedov, N. S. Kasimov, and D. S. Ermakov have developed a model of education for sustainable development (ESD) based on the competency-based approach. In the Republic, the development of geographical education and its geoecological aspects have been fundamentally studied by Academician P. G'. G'ulomov and Professors A. N. Rafikov and P. S. Sultonov. From a pedagogical perspective, the problems of

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HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
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developing students' ecological culture and thinking have been reflected in the works of scholars such as N. Alimqulov, Sh. Avazov, and J. O. Tolipova. Nevertheless, the methodological foundations and comprehensive pedagogical toolkit for developing competence in sustainable development in geography lessons at general secondary schools (assessment criteria, interdisciplinary integrative models, and problem-based project technologies) have not been conceptualized as an integrated methodological system.

The purpose is to systematize the methodological approaches to the formation and development of students' competence in the concept of sustainable development within the school geography education system and to provide a scientific and theoretical substantiation of its pedagogical mechanisms.

Leading scientific schools in the West and Asia regard geography education not merely as a collection of spatial information, but as a key means of developing sustainability competencies.[1]

International studies have systematically demonstrated the role of geography education in developing students' systems thinking, anticipatory competence, and strategic action skills. It has been established that problem-based spatial inquiries and place-based education in geography lessons significantly enhance students' ability to interpret sustainability issues.

An analysis of educational reforms in 2024–2026 shows that Japan introduced the subject "Integrated Geography" into its upper secondary school geography curriculum. This reform is directly based on the standards of PISA studies and the need to build a sustainable society, and it includes sub-modules on natural disasters and their prevention. In the experiences of China and South Korea, the extent to which secondary school textbooks incorporate the ideas of the Sustainable Development Goals (SDGs) has also been examined through empirical surveys conducted among teachers and students, with positive methodological effectiveness recorded.[2]

In the experience of European Union countries (particularly Finland) and countries that have adopted sustainable education strategies (2021–2026), the development of green skills is not limited to classroom instruction. They rely on the synergistic integration of school administration, the community, and the curriculum. However, at the international level, the limited number of instructional hours, insufficient teacher preparation, and resource shortages are identified as the main barriers to the full implementation of sustainability education.[3]

After the Republic of Uzbekistan adopted the national conceptual foundations of the Sustainable Development Goals (SDGs) in 2015, greater attention was paid to the issues of ecologization of the education system in pedagogical research. Over the past five years, scholars in the Republic have conducted a number of studies aimed at reforming school geography education on the basis of the competency-based approach.

In local studies, the theoretical aspects of ecological-systemic, triadic (triad: nature–human–economy), and "green economy" approaches are being actively analyzed in the study of the concept of sustainable development. Educational scholars are putting forward the need to move beyond merely

[1] https://journal.pubsains.com/index.php/jgs/article/download/443/181
[2] https://www.mdpi.com/2071-1050/10/11/3896
[3] https://unece.org/sites/default/files/2025-05/ALBANIA_NIR_report.pdf

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ISSN: 2058-5519|Impact factor-15.9
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describing natural components in school textbooks and to integrate the dynamics of socio-economic resources.[4]

Methodologies for incorporating such modules as climate change, alternative energy sources, and water conservation culture into school geography curricula are being developed by higher education and research institutions of the Republic (for example, TDPU, CHDPU, and NUUz). A distinctive feature of national research is that the global principles of sustainable development are conveyed to students through the prism of regional geoecological problems (for example, the Aral Sea disaster, desertification processes, and shortages of drinking water).

An analysis of national literature shows that although students' "ecological culture" and "geographical knowledge" have been extensively studied, a precise criterial system (indicators) for assessing competence in sustainable development, as well as a system of interactive cases that stimulate practical action competence in geography lessons, have not yet been sufficiently developed as an integrated methodology.

A comparative analysis of international and national experiences shows that modern geography education requires students to possess not only factual knowledge but also a subjective sense of involvement in global environmental and economic problems and practical action skills. This study is aimed at filling the existing conceptual and practical gaps by adapting the international trends of "systemic spatial analysis" to the national geography education system.

The methodological architecture of this study is aimed at transforming the content of school geography education in the context of the concept of sustainable development, empirically assessing students' functional literacy, and developing invariant models of the pedagogical process. To ensure the objectivity and impartiality of the study, a mixed-methods research design encompassing cognitive-methodological analysis and experimental-pedagogical verification methods was employed.

1. Empirical Base and Object of the Study

The experimental work of the study was conducted during the 2024–2025 academic year on the basis of geography lessons in general secondary schools. Sampling groups were formed to test the empirical model. A total of 240 upper-grade students (9th grade) and 12 higher- and first-category geography teachers were involved in the experiment. The sample was divided into two groups using the cluster sampling method:

Control Groups (CG, n=120): Lessons were conducted in accordance with the current state educational standards and the structure of traditional textbooks, mainly in the form of information transmission (retransmission).

Experimental Groups (EG, n=120): Integrative modules aimed at developing competence in sustainable development, problem-based project cases, and the "Green Audit" methodology were introduced into the learning process.

2. Research Methods and Instrumentation

During the study, a set of mutually synergistically interconnected methods was implemented to test the conceptual hypothesis:

Theoretical-Comparative Analysis: The extent to which the content of school geography textbooks, curricula, and international assessment programs (PISA – Global Competence block)

[4]https://www.researchgate.net/publication/378515988_Barqaror_rivojlanish_konsepsiyasini_tadqiq_qilish_yondashuvlari_tahlili

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ISSN: 2058-5519|Impact factor-15.9
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incorporates the Sustainable Development Goals (SDGs) was comparatively examined using the content analysis method.

Sociological and Diagnostic Methods: Modified questionnaires, testing procedures, and pedagogical observation cards were used to identify students' ecological and geographical values.

Pedagogical Experiment: At the formative stage, the nonlinear relationships within the "Nature–Human–Society–Economy" macrosystem were modeled through practical learning tasks in geography lessons.

3. Criteria for Assessing Competence

The level of students' competence in the concept of sustainable development was differentiated from socio-psychological and didactic perspectives on the basis of three fundamental coordinates (components):

Cognitive-Conceptual Component: The depth and systematic nature of theoretical knowledge about global climate change, resource scarcity, desertification, and the principles of sustainable development.

Pragmatic-Activity Component: The ability to interpret local and global geoecological problems using maps, GIS, and statistical data, and to propose alternative solutions (projects).

Axiological-Motivational Component: An ecocentric attitude toward the environment, resource-saving personal behavior (environmental responsibility), and a system of values.

The level of formation of these components was assessed using a specially developed criterial matrix based on a three-level (low, medium, high) scoring scale.

4. Mathematical-Statistical Processing

Mathematical and statistical analysis methods were applied to verify the reliability of the quantitative data obtained from the experimental and control groups and to demonstrate that the effect of the pedagogical intervention was not due to chance. The data were processed using the SPSS 26.0 software package. To determine the differences between the groups and the statistical significance of the conceptual hypothesis, Student's t-test was calculated, while Pearson's chi-square (χ^2) criterion was calculated to compare empirical frequencies. The significance level of statistical differences was accepted at $p < 0.05$.

ANALYSIS AND RESULTS

1. Comparative Analysis of Empirical Results

The initial diagnostic results obtained before the start of the experimental work showed that the average level of knowledge about sustainable development was almost the same in both groups (42.5% in the EG and 41.8% in the CG). However, after the introduction of interactive cases and "Green Audit" modules into geography lessons, conceptual differentiation (divergence) between the groups was observed in the final results.

At the end of the experiment, the students' indicators of competence in sustainable development are presented in the following table:

Competence Levels	Control Group (CG, n=120) — At the Beginning of the Experiment (%)	Control Group (CG, n=120) — At the End of the Experiment (%)	Experimental Group (EG, n=120) — At the Beginning of the Experiment (%)	Experimental Group (EG, n=120) — At the End of the Experiment (%)
High level	10,8	13,3	11,7	34,2

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ISSN: 2058-5519|Impact factor-15.9
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Medium level	45,0	48,3	43,3	52,5
Low level	44,2	38,4	45,0	13,3

The data in the table show that, while the proportion of students at the high level in the control group, which continued to follow the traditional educational scheme, increased by only 2.5%, this indicator increased by 22.5% in the experimental group, which received instruction based on the innovative methodology. The proportion of students at the low level in the EG, meanwhile, sharply decreased from 45.0% to 13.3%.

2. Dynamics by Components

To gain a deeper understanding of the changes in the groups over time, each component was analyzed separately:

Cognitive-Conceptual Component: EG students were able to analyze not only ecological terms but also the functional relationships among the 17 Sustainable Development Goals (SDGs) of the United Nations. In particular, elements of systems thinking were demonstrated in explaining the impact of climate change on the global economy and regional demography.

Pragmatic-Activity Component: In project-based work on the topic "Local Geoecological Problems and Their Solutions," EG students used elements of geographic information systems (GIS) and statistical forecasts. Their practical action competence was recorded at a level 2.8 times higher than that of the CG.

Axiological-Motivational Component: In response to questions in the tests and questionnaires concerning a "green consumption culture" and motivation for resource conservation, 84% of EG students responded positively and from the perspective of subjective involvement (the corresponding figure in the CG was 46%).

3. Mathematical-Statistical Reliability

To demonstrate that the obtained results were not due to chance and to establish the high effectiveness of the proposed methodological system, the statistical difference between the groups was tested using Pearson's χ^2 (chi-square) criterion. The chi-square value calculated from the results at the end of the experiment was significantly higher than the critical value (when [image]). This provides a basis for rejecting the null hypothesis at the significance level of $p < 0.01$ and scientifically confirming that the positive changes in the experimental group were specifically the result of the sustainable development methodology introduced into school geography education.

CONCLUSION AND RECOMMENDATIONS

The results of the study show that transferring geography education from the traditional descriptive model to an integrative model oriented toward the concept of sustainable development fundamentally changes students' worldview.

These results empirically confirm the theory of "systems thinking for sustainability" previously proposed by J. Sterling (2021) and D. S. Ermakov (2022). However, unlike foreign studies, our model organically synthesizes global problems with the local geoecological situation (climate change, desertification, and freshwater problems in the Aral Sea basin). This made it possible to develop a real practical manifestation of the principle "Think globally, act locally" among students.

At the same time, several pedagogical problems that hinder the full implementation of sustainable development ideas in school geography lessons were identified during the study:

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ISSN: 2058-5519|Impact factor-15.9
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The interdisciplinary relationship between the economic and ecological blocks in current textbooks has not been sufficiently conceptualized;

The majority of geography teachers lack specialized competencies in sustainable development methodology and case-study technologies.

To overcome these limitations, it is considered appropriate to introduce in greater depth modules on Education for Sustainable Development (ESD) into the "Methods of Teaching Geography" courses at higher pedagogical education institutions in the future.

The scientific-theoretical and empirical investigation of the problem of developing students' competence in the concept of sustainable development in school geography education made it possible to formulate the following fundamental conclusions:

1. Methodological Conceptualization

Competence in sustainable development is not merely a mechanical sum of environmental and economic knowledge, but rather a complex transprofessional meta-competence based on the synthesis of systemic, synergistic, and axiological approaches. Due to the objective nature of geography as a subject (the Nature–Human–Society–Economy macrosystem), geography has a greater potential for didactic integration in developing this competence compared with other interdisciplinary systems.

2. Pedagogical Effectiveness

The results of the pedagogical experiment demonstrated the high effectiveness of the proposed methodological model. It was empirically established that in the experimental group (EG), the proportion of students with a high level of competence in sustainable development increased from 11.7% to 34.2%, while the proportion at the low level decreased from 45.0% to 13.3%. Mathematical-statistical analysis (Pearson's χ^2 criterion, [image]) confirmed that the positive shifts obtained were not due to chance and confirmed the reliability of the proposed methodology.

3. Component-Based Development

Project-based learning and problem-based case technology not only increased students' cognitive (knowledge) level, but also fundamentally transformed their practical action competence (pragmatic component) and their subjective involvement in environmental issues and sense of resource conservation (axiological component).

Based on the scientific and practical needs identified during the study, the following recommendations are proposed for further improving the school geography education system:

For curricula and textbooks: Geoecological and economic topics included in geography textbooks for general secondary schools (particularly grades 7–9) should be reintegrated with the indicators of the 17 Sustainable Development Goals (SDGs) of the United Nations. It is advisable to reduce the proportion of dry factual and descriptive material in textbooks and, instead, increase the number of problem-based spatial and environmental tasks and cases that develop systems thinking and critical thinking.

For methodological support: Practical methodological manuals and digital didactic platforms (case banks) should be developed for geography teachers on organizing "Green Audit," "Future Scenarios," and "Local Geoecological Projects" during the teaching process.

For the teacher training system: A special course (or sub-module) entitled "Methods of Education for Sustainable Development (ESD)" should be introduced into the curricula of the "Geography and Methods of Teaching Geography" program at higher pedagogical education

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institutions. This will ensure that future teachers enter schools with the professional competencies required for effective teaching.

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