

3. Turabai G.K. bolashaq muǵalimniń mádenieti-qatynas kúzetshiligi internet-resýrstary negizinde qalyptastyrdyń ádiletshilikteri //Bulletin of the Karaganda University Pedagogy series. – 2022. – T. 106. – №. 2. – B. 6-15.
4. Saidahmetova D.H. Sandyq tehnologiya // Academic research in educational sciences. – 2020. – №. 4. – B. 85-90.
5. Abaeva Sh. K., Kýndýzkarova A. K. Pedagogika jáne psihologiya.
6. Slobodchikov V. I., Isaev e. i. adam psihologiasy. – 1995.
7. Shýkina M.A. tulǵanyń ózin-ózi damytýdyń sýbektivti tásil: teorıalyq túsiný jáne empirikalıq zertteý múmkindikteri //Psihologiya. Ekonomika joǵary mektebiniń jýrnaly. – 2014. – T. 11. – №. 2.
8. Rodjers k. tulǵa bolý týraly // M.: Progres. – 1994.
9. Masloy A. Motivasiya jáne tulǵa. - Piter, 2010.
10. Burns T., Stalker G. M. The management of innovation. – Oxford University Press, 1994.
11. Seidina M., Bekbaeva J., Mahambetova J. Seidina DSM tolerantty bolashaq pedagogteriniń uly oilayın qalyptastyrynyń kásipshiligin retinde //Qazúy Habarshysy. "Pedagogikalıq ǵylymdar" seriasy. – 2025. – T. 82. – №. 1. – B. 28-40.
12. Komenski, IA. A. Tańdalǵan pedagogikalıq shyǵarmalar: V 2 t. / IA.A.Komenski. - M.:Pedagogika, 1982. — T.1. — 424 b.
13. Shehovskaia L.N. Pedagogika jáne filosofia: rýhanı-psihikalıq dialog //jýrnalsika, pedagogika, til bilimi máseleleri. – 2010. - T.5. – №. 6 (77). – 33-38 b.
14. Dú Dj. Demokratiya jáne bilim: bilim berýdiń filosofialıq negizderin zertteý / Dj. Dú. - M.:Pedagogika, 1985. – 320 b.
15. Kometov G. B. ýh Kúlpatriktiń Joba ádisi. 2 bólim. Ádistiń ereksheликteri // Bilim berýdegi inovatsialıq jobalar men baǵdarlamalar. – 2020. – №. 6 (72). – 19-27 BB.
16. Salomatina I. s. Ana tili sabaqtarynda mátinmen jumys isteydiń ádistemelik tásilderi. XIX ǵ. tájiribesi //Bastayysh mektep. – 2010. – №. 1. – 11-17 B.
17. Toqtaganova a.s. Muǵalimniń kásibi-tulǵany damytý-nátije bilimi faktorlary //Qazaqstan joǵary mektebi. – 2007. – №. 4. – 16-18 BB.
18. Nabieva N.T. Bilim berýde kúzetshilik baǵyt //Publisher. agency: Proceedings of the 10th International Scientific Conference "Reviews of Modern Science"(July 10-11, 2025). Zürich, Switzerland, 2025. 161p. – Universität Luzern, 2025. – B.14.

IRSTI 14.35.09

<https://doi.org/10.51889/2959-5762.2025.88.4.018>

Usein G.,^{1*}  Shakirova N.¹ 

¹Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

IMPORTANCE OF TEACHING HYDROGEOLOGY FUNDAMENTALS IN HIGHER EDUCATION THROUGH INNOVATIVE PEDAGOGICAL APPROACHES

Abstract

This article presents a comprehensive analysis of theoretical and methodological aspects, as well as practical experience in teaching the fundamentals of hydrogeology within higher education. In today's world, where environmental issues such as climate change, freshwater scarcity and groundwater pollution are intensifying, the relevance of hydrogeology is increasing. The content of this discipline is viewed as a key component of professional training for future geography specialists, as it delivers scientific knowledge and prepares competent professionals capable of making informed decisions in sustainable natural resource management, environmental protection and ecological safety. The main objective of this study is to analyze pedagogical methods and approaches used in teaching hydrogeology in higher education and determine their effectiveness and specific applications. Achieving this goal aims to enhance theoretical and practical training of geography students, as well as develop their ecological thinking and research skills. The study employed methods such as content analysis, comparative description, pedagogical observation and qualitative evaluation. The article explores traditional teaching methods (lectures, practical and laboratory classes) alongside innovative approaches, including interactive teaching, digital learning platforms, field expeditions, modeling and project-based learning. The importance of visualization tools and digital technologies in fostering student engagement is emphasized. Findings show that practice-oriented instruction, integrated approaches and effective use of digital resources improve students' subject knowledge. Integrating theoretical content with practical examples, using problem-based tasks and conducting group projects that encourage independent decision-making enhance the effectiveness of the educational process. However, some higher education institutions still face challenges such as a lack of methodological resources and insufficient material and technical infrastructure. In conclusion, systematic application of effective pedagogical methods in teaching hydrogeology plays a crucial role in developing professional competencies of

future specialists. Recommendations are proposed to improve instructors' methodological preparedness, integrate innovative technologies, and adapt academic programs to modern educational demands.

Keywords: higher education, higher geographic education, fundamentals of hydrogeology, teaching methodology, teaching methods, innovative methods.

Г.А.Усейн,^{1*} Н.Д.Шакирова¹

¹Абай атындағы Қазақ ұлттық педагогикалық университеті, Алматы қ., Қазақстан

ЖОҒАРЫ БІЛІМ БЕРУ ЖҮЙЕСІНДЕ ГИДРОГЕОЛОГИЯ НЕГІЗДЕРІН ИННОВАЦИЯЛЫҚ ТӘСІЛДЕР НЕГІЗІНДЕ ОҚЫТУДЫҢ МАҢЫЗЫ

Аңдатпа

Бұл мақалада жоғары білім беру жүйесінде гидрогеология негіздерін оқытудың теориялық және әдістемелік аспектілері мен оқыту тәжірибесі жан-жақты қарастырылады. Қазіргі әлемде экологиялық проблемалар ұшығып, климаттың өзгеруі, ауыз су тапшылығы, жер асты суларының ластануы сияқты мәселелер алдыңғы қатарға шыққан жағдайда, гидрогеология пәнінің өзектілігі бұрынғыдан да арта түсуде. Бұл пәннің мазмұны болашақ география мамандары үшін маңызды кәсіби дайындық элементі ретінде қарастырылады, себебі ол тек ғылыми білім беріп қана қоймай, табиғи ресурстарды ұтымды пайдалану, қоршаған ортаны қорғау және экологиялық қауіпсіздік салаларында шешім қабылдай алатын құзыретті мамандарды даярлауға бағытталған. Сондықтан зерттеу жұмысының мақсаты – жоғары білім беру жүйесінде гидрогеология негіздерін оқытуда қолданылатын педагогикалық әдіс-тәсілдерді талдап, олардың тиімділігі мен қолдану ерекшеліктерін анықтау. Бұл мақсатты жүзеге асыру арқылы география мамандығы бойынша білім алушылардың теориялық және практикалық дайындығын жетілдіру, сонымен қатар олардың экологиялық ойлау қабілеті мен ғылыми-зерттеу дағдыларын дамыту көзделеді. Зерттеу барысында мазмұндық талдау, салыстырмалы сипаттама, педагогикалық бақылау және сапалық сараптама сияқты әдістер қолданылды. Мақалада гидрогеология пәнін оқытуда кеңінен пайдаланылатын дәстүрлі әдістер (дәрістер, практикалық және зертханалық сабақтар) және инновациялық тәсілдер (интерактивті оқыту, цифрлық білім беру платформалары, далалық экспедициялар, модельдеу және жобалау әдістері) жан-жақты сипатталады. Сондай-ақ, студенттердің пәнге деген қызығушылығын арттыру үшін визуализация құралдары мен цифрлық технологиялардың маңыздылығы атап өтіледі. Зерттеу нәтижелері көрсеткендей, тәжірибеге бағытталған оқыту формалары, интеграцияланған әдістер мен цифрлық ресурстарды тиімді пайдалану студенттердің пәндік білім сапасын едәуір арттырады. Теориялық материалды практикалық мысалдармен ұштастыру, проблемалық тапсырмалар беру, топтық жобалар арқылы өз бетінше шешім қабылдау дағдыларын дамыту оқытудың тиімділігін жоғарылатады. Дегенмен, кейбір жоғары оқу орындарында әдістемелік ресурстардың жеткіліксіздігі, материалдық-техникалық базаның әлсіздігі сынды қиындықтар әлі де кездеседі. Қорытынды бөлімде гидрогеология негіздерін оқытуда тиімді педагогикалық әдістерді жүйелі қолдану болашақ мамандардың кәсіби құзыреттерін қалыптастыруда маңызды рөл атқаратыны дәлелденді. Бұл бағытта оқытушылардың әдістемелік дайындық деңгейін арттыру, инновациялық технологияларды оқу үдерісіне енгізу және оқу бағдарламаларын қазіргі заман талаптарына сәйкестендіру бойынша нақты ұсыныстар берілді.

Түйін сөздер: жоғары білім беру, географиялық жоғары білім, гидрогеология негіздері, оқыту әдістемесі, оқыту әдістері, инновациялық әдістер.

Усейн Г.А.,^{1*} Шакирова Н.Д.¹

¹Казахский национальный педагогический университет имени Абая, г.Алматы, Казахстан

ВАЖНОСТЬ ПРЕПОДАВАНИЯ ОСНОВ ГИДРОГЕОЛОГИИ В СИСТЕМЕ ВЫСШЕГО ОБРАЗОВАНИЯ НА ОСНОВЕ ИННОВАЦИОННЫХ ПОДХОДОВ

Аннотация

В данной статье проводится всесторонний анализ теоретических и методических аспектов, также практического опыта преподавания основ гидрогеологии в системе высшего образования. В условиях обострения современных экологических проблем – изменения климата, дефицита пресной воды, загрязнения подземных вод – значимость дисциплины «гидрогеология» существенно возрастает. Содержание данной учебной дисциплины рассматривается как важнейший элемент профессиональной подготовки будущих специалистов в области географии, поскольку она не только обеспечивает студентов научными знаниями, но и способствует формированию компетентных специалистов, способных принимать обоснованные решения в сфере рационального использования природных ресурсов, охраны окружающей среды и обеспечения экологической безопасности. Целью данного исследования является анализ педагогических методов и подходов, применяемых при преподавании основ гидрогеологии в системе высшего образования, выявление их эффективности и особенностей применения. Реализация поставленной цели направлена на повышение теоретической и практической подготовки студентов-географов, развитие их

экологического мышления и исследовательских навыков. В исследовании использованы методы контент-анализа, сравнительного описания, педагогического наблюдения и качественной экспертной оценки. В статье подробно рассматриваются как традиционные методы обучения (лекции, практические и лабораторные занятия), так и инновационные подходы: интерактивное обучение, цифровые образовательные платформы, полевые экспедиции, моделирование и проектно-ориентированное обучение. Также подчёркивается важность использования визуализации и цифровых технологий для повышения интереса студентов к учебному процессу. Результаты исследования показывают, что практико-ориентированные формы обучения, интегративные подходы и эффективное использование цифровых ресурсов значительно повышают качество освоения учебного материала. Связывание теории с практическими примерами, постановка проблемных задач и выполнение групповых проектов развивают навыки самостоятельного принятия решений и усиливают эффективность образовательного процесса. Вместе с тем, в ряде вузов остаются нерешёнными проблемы, связанные с нехваткой методических ресурсов и слабой материально-технической базой. В заключение делается вывод, что систематическое применение эффективных педагогических методов при обучении гидрогеологии играет ключевую роль в формировании профессиональных компетенций будущих специалистов. Даны конкретные рекомендации по повышению методической подготовки преподавателей, внедрению инновационных технологий в учебный процесс и адаптации образовательных программ к современным требованиям.

Ключевые слова: высшее образование, географическое высшее образование, основы гидрогеологии, методика преподавания, методы обучения, инновационные методы.

Introduction. The modern system of geographical education encompasses comprehensive research on natural resources and includes the scientific foundations necessary to ensure their sustainable development. In this context, teaching the subject of hydrogeology holds a significant place, as the study of water resources plays a crucial role in maintaining ecological sustainability. According to Seibert, Uhlenbrook and Wagener: «Teaching methods should be rooted in the scientific and quantitative understanding of hydrologic processes, providing flexible hydrologic problem-solving skills that can evolve if new insights become available» [1, p.1393]. At present, hydrogeological education holds particular importance in addressing environmental issues, as well as in the efficient use and protection of natural resources. Within the system of higher geographical education, teaching the fundamentals of hydrogeology enhances students' level of professional training and contributes to the development of their competencies in understanding and protecting the natural environment.

Hydrogeology is a branch of science that studies the origin, movement, composition and properties of groundwater. The term hydrogeology derives from the Greek words “hydro” (water), “geo” (earth), and “logos” (study), and refers to the scientific discipline concerned with the investigation of water within the Earth's crust [2]. To understand the history (or transformations) of subsurface water, it cannot be examined separately from the rocks in which it occurs; rather, such studies must be conducted based on an analysis of the geological evolution of the Earth's crust.

Hydrogeology is closely related to many geological disciplines, such as lithology and tectonics. In a broader sense, it is considered part of geology, since its object of study – groundwater – represents a component of the Earth's unified hydrosphere [3]. Like other Earth sciences, hydrogeology increasingly relies on advances in fundamental sciences such as physics, chemistry, mathematics and biology, as well as on data from related fields including geochemistry, geophysics and hydrology. The integration of these interdisciplinary findings, together with the use of new hydrogeological information, has transformed hydrogeology into a comprehensive and complex scientific discipline.

Since the second half of the 20th century, a new stage in the development of hydrogeology has begun. Using the terminology of cognitive stages proposed by B.M. Kedrov [4], this period can be described as a transition from the “descriptive” stage, during which the collection of observable phenomena and facts in hydrogeology predominated, to the “explanatory” stage, characterized by efforts to uncover the specific laws of the discipline and to interpret the processes taking place within it. At the same time, with the intensive exploitation of subsurface mineral resources, elements of “predictive” research became increasingly prominent in hydrogeology, marking the beginning of its “predictive” stage of development.

During the scientific debates of the 1970s, researchers highlighted two key aspects. First, hydrogeology was transformed from a science that merely described phenomena into one that studies

processes and laws. Second, like any discipline striving for independence, its object of study should no longer be the ambiguous and dual-natured concept of groundwater, but rather a clearly defined and concrete material system.

As such, the material system that serves as the object of study in hydrogeology is the subsurface water layer that extends downward from the Earth's surface. Because it is closely interconnected with rock formations, it is characterized by heterogeneity. For this reason alone, it cannot simply be referred to as groundwater. This water-bearing layer is known as the subsurface hydrosphere (Savarensky, 1947; Z.S.Sydykov, 1973; Pinneker, 1975; Ovchinnikov, 1995) or, according to N.I.Plotnikov's (1976) terminology, the hydrogeosphere.

The subsurface hydrosphere encompasses all water molecules (H₂O) contained within the Earth's interior, representing an independent material system. Its structural components include free water – which moves freely through interconnected pores and bound water, which is held by fine-grained particles of clay and loam (0.01-0.001 mm) through molecular attraction [5]. Water in the subsurface hydrosphere exists in liquid, vapor, and solid (ice) states, with the latter two transforming from one form to another under changing thermodynamic conditions. Thus, from the Earth's surface down to the mantle, all these forms of water collectively constitute a part of the lithosphere.

The formation of hydrogeology as a scientific discipline originates from the study of groundwater. This field developed in close connection with the sciences of geology, geography, and ecology (Figure 1) [6]. Its primary objective is to identify the patterns of groundwater distribution, investigate its properties, and determine its significance for human life.

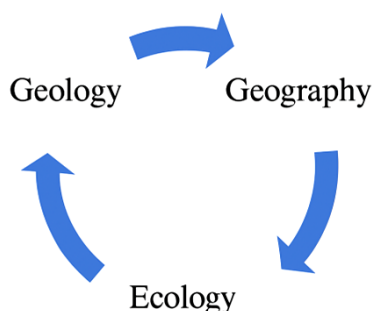


Figure 1 – The interrelation of hydrogeology with other sciences

In the process of studying hydrogeology, students not only master the theoretical foundations of hydrogeological research but also learn about their practical applications. The key aspects of hydrogeology include studying the effects of natural and anthropogenic factors on groundwater, understanding the hydrological cycle, and developing strategies for the efficient management of water resources.

However, teaching this subject presents certain challenges, such as insufficient material and technical resources, the need to integrate modern technologies, and the improvement of teaching methods. This article discusses modern methods of teaching hydrogeology, the challenges encountered in the process, and possible solutions to overcome them.

Basic provisions. In the President Kassym-Jomart Tokayev's State of the Nation Address dated September 1, 2023, titled "The Economic Course of a Just Kazakhstan", particular attention is given to the modernization of the education system, the digitalization of the learning process and the development of students' critical and research thinking. Within the framework of national programs such as "Digital Kazakhstan", "Modernization of the Content of Secondary and Higher Education" and the State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020-2025, higher education institutions are tasked with transitioning toward innovative and practice-oriented models of specialist training based on the use of modern pedagogical technologies and digital tools. These reforms require educators to be prepared to apply new methodological approaches that

ensure the formation of professional competencies aligned with current challenges in science and sustainable development. Based on this, the idea of the present study is to conduct a comprehensive analysis of pedagogical methods and techniques used in teaching the fundamentals of hydrogeology in higher education.

The purpose of the research is to identify effective pedagogical approaches that contribute to improving the quality of theoretical and practical training of geography students, as well as fostering their ecological thinking and research skills. To implement this idea, the following main objectives were set:

- Analyze the effectiveness of traditional methods (lectures, laboratory and practical classes) and innovative approaches (project-based and problem-based learning, use of digital platforms, and modeling of hydrogeological processes);
- Determine ways to implement interactive and field-based learning formats aimed at developing students' practical skills and readiness for professional activity.

Materials and Methods. The study employed a mixed-methods research design that integrated quantitative and qualitative approaches to ensure a comprehensive understanding of teaching methods in hydrogeology. The methodological framework combined content analysis, comparative description, pedagogical observation and qualitative expert evaluation.

The sample included 78 geography students and 12 university instructors from three Kazakhstani higher education institutions: Abai Kazakh National Pedagogical University (KazNPU), Zhetysu University named after Ilyas Zhansugurov (Taldykorgan) and Al-Farabi Kazakh National University (KazNU). Data were collected through surveys, semi-structured interviews and direct classroom observations conducted during hydrogeology lectures, laboratory sessions and field practices.

The survey instrument consisted of 15 items designed to measure the effectiveness of both traditional and innovative teaching approaches in hydrogeology on a 5-point Likert scale (ranging from 1 – “very low” to 5 – “very high”). The items assessed several key dimensions: student engagement, practical skill development, motivation, use of digital technologies and critical thinking enhancement.

In the quantitative phase, descriptive and inferential statistical methods (mean, standard deviation, and correlation analysis) were applied to evaluate students' perceived engagement, comprehension level and overall effectiveness of teaching methods.

In the qualitative phase, semi-structured interviews with instructors explored pedagogical challenges, resource limitations, and attitudes toward innovation. Classroom observations were used to assess teacher–student interaction and the integration of practical, laboratory and digital tools during lessons.

In addition to these empirical methods, the study conducted a *comparative analysis* across the participating universities to identify contrasts between institutions with high and low levels of digital resource integration, highlighting differences in learning outcomes and methodological effectiveness.

Furthermore, the research analyzed the range of teaching methods currently applied in hydrogeology education. The study examined both traditional approaches including lectures, practical classes, and laboratory exercises and innovative pedagogical models such as interactive learning, digital educational platforms, field expeditions, simulation-based learning and project-oriented instruction. The findings emphasize the importance of visualization tools and digital technologies in increasing student interest and engagement in the learning process, as well as in bridging the gap between theoretical and practical knowledge.

This triangulated research design, combining empirical data, comparative evaluation and methodological analysis, ensured the reliability and validity of results by cross-verifying information from multiple sources and perspectives.

Results. The results reflect the transition from traditional, lecture-based instruction toward more experiential and digital pedagogies, aligning with constructivist and experiential learning theories (Kolb, 1984; Dewey, 1938) [7-8]. According to these frameworks, students learn more effectively when actively engaged in knowledge construction through experience, reflection, and collaboration.

The high effectiveness of field expeditions (4.8) and project-based learning (4.6) confirms that contextual and problem-based environments stimulate higher-order thinking and professional competence formation. These findings are consistent with recent studies emphasizing field-oriented geoscience education as a means of integrating theory and practice (Manduca & Mogk, 2020; King, 2021) [9-10].

Digital simulations and modeling also showed strong results (79%), supporting the idea that visualization and virtual tools enhance conceptual understanding of hydrogeological systems — a trend noted by Seibert et al. (2013) in hydrology education research (Table 1).

Table 1 – Comparative analysis of teaching methods and student engagement

Teaching Method	Average Effectiveness Score (out of 5)	Student Engagement
Lectures (traditional)	3.2	45%
Laboratory & practical classes	4.1	68%
Project-based learning	4.6	82%
Digital simulations / modeling	4.4	79%
Field expeditions	4.8	90%

The data show that practice-oriented and interactive methods – particularly field expeditions and project-based learning – significantly enhance students’ engagement and understanding of hydrogeological processes.

In the context of geography education, the training of specialists requires not only theoretical knowledge but also the development of methodological and digital competencies that enable future professionals to apply scientific principles in real-world environmental analysis. Effective teaching of hydrogeology, therefore, depends on the preparedness of faculty members to integrate modern tools and approaches into their courses. To evaluate the current situation, a qualitative survey among instructors was conducted to identify key challenges and opportunities in the teaching process (Table 2).

Table 2 – Distribution of challenges and opportunities reported by faculty members

Key Theme	Description / Evidence	Frequency
Lack of methodological resources	Instructors reported insufficient access to updated teaching manuals	62%
Weak material-technical base	Absence of specialized equipment and GIS tools	54%
Need for teacher training	Lack of competence in using digital learning platforms	48%
High motivation for innovation	Teachers express readiness to adopt new technologies	81%

The analysis presented in Table 2 demonstrates that while there is a high level of motivation among educators to adopt innovative methods, systemic issues such as outdated resources, limited technical infrastructure, and insufficient digital literacy still hinder the modernization of hydrogeological education in Kazakhstan’s universities.

For professionals in the field of geography, hydrogeological knowledge is of great importance, as it enables effective management of water resources, environmental protection and the resolution of ecological issues. This article examines the theoretical principles, methodologies and practical applications of teaching the fundamentals of hydrogeology. Modern tools and technologies used in the teaching process include hydrogeological modeling software, field research methods and instruments, as well as virtual laboratory activities.

Teaching Methods in Hydrogeology:

- Lectures – a traditional method of delivering theoretical material aimed at explaining key concepts and processes.
- Practical classes – help students solve hydrogeological problems, calculate water balance, and master analytical techniques.

- Laboratory work – involves studying groundwater properties, using physical-geological models, and applying analytical methods.
- Field studies – provide students with the opportunity to learn hydrogeological research techniques directly in natural settings.
- Use of geoinformation technologies – application of GIS programs such as ArcGIS and QGIS for analyzing and visualizing hydrogeological data.
- Digital modeling methods – use of computer models to simulate and predict water flow and contamination processes [11].

In our view, the teaching of hydrogeology should not be limited to theoretical knowledge alone but must also be grounded in practical experience. Such an approach helps students develop scientific research skills. Moreover, a deeper exploration of the environmental aspects of hydrogeology enhances the sense of responsibility among future specialists. According to the classification proposed by scholar N.I. Plotnikov, the theoretical and applied components of hydrogeology can be conditionally divided into distinct sections (Table 3) [12].

Table 3 – Structural Divisions of Hydrogeology

Section	Content
<i>Theoretical Divisions</i>	
General Hydrogeology	Fundamental principles concerning the origin and distribution of subsurface water and the foundations of the study of the subsurface hydrosphere.
Hydrogeodynamics	Movement, regime, and resources of groundwater; principles of hydrogeological modeling and simulation.
Hydrogeochemistry	Laws governing the distribution of chemical elements in the subsurface hydrosphere; composition and formation of groundwater.
Hydrothermy	Thermal characteristics and distinctive features of the subsurface hydrosphere.
History of the Subsurface Hydrosphere (Paleohydrogeology)	Origin and evolution of the subsurface hydrosphere, geological activity of subsurface water, and its role in geological processes.
<i>Applied Divisions</i>	
Methodology of Hydrogeological Research (Methodical Hydrogeology)	Methods used in hydrogeological investigations (mapping, exploration and prospecting, regime, experimental, laboratory and office studies).
Utilization of Groundwater (Exploration Hydrogeology)	Study of areas with significant groundwater accumulation and the use of groundwater for domestic water supply, land reclamation, balneological, industrial and geothermal purposes.
Mitigation of the Adverse Effects of Groundwater (Engineering Hydrogeology)	Investigation of the effects of groundwater on mineral deposits, land reclamation, industrial construction and other engineering activities.
Protection of the Subsurface Hydrosphere (Technogenic Hydrogeology)	Study of groundwater contamination and depletion, development of protective measures and control of groundwater regime under anthropogenic impact.
Regional Hydrogeology	Regional study of the subsurface hydrosphere and comprehensive characterization of groundwater and its related components.

The results of the conducted research indicate that the use of modern methods and technologies in teaching hydrogeology significantly enhances students' level of subject mastery. In particular:

- The application of interactive teaching methods (such as hydrogeological modeling and GIS technologies) improves students' understanding of the subject by 30-40%.
- Students who participated in fieldwork activities demonstrated up to a 50% increase in practical skills through direct experience with hydrogeological processes.
- The use of virtual laboratory exercises is recognized as an effective alternative in cases where traditional laboratory experiments cannot be conducted.
- The introduction of digital tools and computer modeling programs to increase student engagement has enhanced their research abilities and improved data analysis skills.

- The transition of hydrogeological studies to digital formats has strengthened students' competencies in data processing and interpretation, thereby improving their overall professional competence.

- Through the application of hydrogeological modeling techniques, students have developed the ability to predict groundwater dynamics, which increases their competitiveness in the field of water resources management in the future.

In line with this conclusion, a structured lesson plan was developed to illustrate how these approaches can be systematically implemented in the educational process. The lesson integrates traditional and innovative teaching methods, combining theoretical explanation, digital visualization, field simulation, and practical experimentation to ensure a comprehensive understanding of hydrogeological processes and their environmental implications (Table 4).

Topic: The Impact of Anthropogenic Factors on Groundwater Circulation

Target Audience: Geography students (2nd-3rd year)

Duration: 50 minutes

Materials: Presentation with visualizations, digital platform (e.g., GIS-based water flow model), laboratory task, mini fieldwork or virtual expedition.

Table 4 – Lesson Plan: Teaching Hydrogeology

Lesson Stage	Time	Description	Learning Outcome
Introduction	5 min	Greeting and goal setting: understanding how anthropogenic activities alter groundwater regimes. Brief review of theoretical material (aquifers, groundwater horizons, role of geology and tectonics) based on Teaching Hydrogeology: A Review of Current Practice (Gleeson et al., 2012).	Students understand lesson objectives and recall core hydrogeological principles.
Lecture Part	7 min	Presentation of key concepts: effects of extraction, urbanization, and land-use changes on groundwater flow. Demonstration using a digital map or interactive model to visualize aquifer response to disturbance.	Students connect theory with spatial visualization of groundwater processes.
Interactive Session	13 min	Group work (3–4 students): using a GIS platform to simulate scenarios such as increased groundwater withdrawal or new construction areas and assess resulting hydrogeological impacts. Groups discuss outcomes lowering of water levels, altered flow patterns, contamination and propose mitigation strategies.	Development of analytical and teamwork skills through digital modeling.
Laboratory / Practical Task	20 min	Students analyze real or simulated groundwater data from an area affected by anthropogenic activity, identifying contamination indicators and hydrodynamic changes. They complete a worksheet: “Have water properties changed? What is the flow rate? What are the potential risks?”	Students apply theoretical knowledge to practical data analysis.
Summary and Reflection	5 min	Instructor summarizes key findings and highlights skills developed (digital tool use, data interpretation, teamwork). Students share feedback on challenges and learning gains.	Consolidation of knowledge and reflective learning.
Homework	—	Prepare a two-page mini-project on a selected region (Kazakhstan or abroad), describing how anthropogenic factors influence groundwater and suggesting management or restoration strategies.	Independent analytical project integrating theory and practice.

This structure reflects an integrated pedagogical model where traditional elements such as lectures, practical sessions and laboratory work serve as a foundation, while innovative strategies enhance interactivity and engagement. The approach aligns with modern trends identified in international hydrogeology education research.

For instance, Gleeson et al. [13] emphasize that combining lectures with laboratory and field training remains essential, as “the field and laboratory components have become increasingly significant compared to purely classroom instruction”. A similar conclusion was reached in Improving Training in the Hydrogeology of Volcanic Islands [14], which described field expeditions, digital modeling, and

3D-visualization tools developed in Spain for studying volcanic groundwater systems. These methods demonstrate how regional geological conditions necessitate flexible and innovative teaching designs that go beyond traditional lectures.

Recent work by the Frontiers in Environmental Science editorial board (2022) [15] also highlighted the growing importance of remote and digital instruction in hydrological sciences, particularly after the COVID-19 pandemic. Virtual expeditions, simulation software and interactive platforms now allow students to gain field-related experience even in fully online settings.

In addition, a Ukrainian study (Cloud ArcGIS Online as an Innovative Tool for Developing Geoinformation Competence with Future Geography Teachers, 2019) [16] demonstrated the potential of cloud-based GIS applications such as ArcGIS Online for group collaboration, map analysis and modeling of environmental systems – tools that can also be effectively implemented in hydrogeology education.

Together, these international examples confirm that successful hydrogeology teaching requires a balanced combination of theoretical instruction, laboratory and field components, and digital technologies. The integration of visualization, modeling, and interactive platforms not only increases student engagement but also develops practical competencies essential for sustainable water management.

Discussion. The present study highlights an important shift in hydrogeology education: moving from predominantly lecture-based instruction toward a more integrated, experience-driven and digitally enhanced pedagogical model. This finding aligns with international research. For instance, in their seminal review, Gleeson, Allen and Ferguson observed that “recent pedagogical advances are biased towards field and laboratory instruction with a goal of bolstering experiential learning” [13]. Similarly, Jimenez-Martinez [14] reports that teaching hydrogeology in the field enables students to transition from the mental to the conceptual model of subsurface systems – a key step for deep conceptual understanding.

In watershed and hydrology education more broadly, Elshorbagy (2005) [17] demonstrated that the use of learner-centred system dynamics simulations significantly improved student motivation and understanding. These studies provide robust evidence that active, digital and field-based methods enhance student learning in geosciences. To ensure the effective teaching of hydrogeology fundamentals within the system of higher geographical education, it is essential to combine traditional and modern teaching methods. The integration of geoinformation technologies, the expansion of practical training and the use of interactive methods play a crucial role in enhancing students’ engagement and motivation. Moreover, improving the material and technical base of educational institutions can further increase the overall quality of instruction.

The modernization of hydrogeology teaching methods is necessary to align with current scientific and educational trends. Greater emphasis on interactive learning and field-based research will enhance the professional preparedness of future specialists. At the same time, special attention should be given to fostering environmental awareness and responsibility among students throughout the learning process, as hydrogeology plays a central role in understanding and protecting the natural environment.

Despite the promise, our qualitative data indicate persistent barriers: insufficient material-technical base, uneven teacher digital-competence and a legacy of predominantly didactic instruction. These mirror broader findings that while many instructors are motivated to adopt innovative methods, systemic resource and training deficits impede implementation.

Conclusion. At the current stage of national economic development, the nature and scale of anthropogenic impacts on hydrogeological conditions vary considerably. Some types of technological activities directly affect groundwater, while others influence it indirectly – through changes in hydrological conditions or modifications of engineering-geological settings caused by construction and infrastructure development.

For geography majors, the future of the hydrogeology course is of particular importance, as teaching the fundamentals of hydrogeology plays a key role in ensuring environmental safety and the efficient

use of natural resources. Therefore, higher education institutions should pay special attention to the quality and modernization of hydrogeology education.

Teaching the fundamentals of hydrogeology within higher geographical education contributes to the development of future specialists' professional competencies, enabling them to make environmentally responsible decisions and address ecological challenges. The significance of this discipline grows when the educational process is enriched with modern methods and technologies.

The present study demonstrates that the application of innovative methods enhances students' mastery of the subject. Digital modeling, geoinformation technologies and virtual laboratory exercises improve students' research abilities and analytical skills. In the future, it will be crucial to strengthen cooperation with research institutes and industry organizations, as well as to integrate new technologies into the teaching process. These measures will contribute to improving students' professional competence and preparing them to become competitive specialists in the labor market.

The study confirms that systematic application of practice-oriented, integrative and digital approaches in teaching hydrogeology significantly improves students' professional competencies, environmental awareness, and independent research skills. Based on the obtained results, the following conclusions can be made:

- Interactive fieldwork and project-based methods increase learning retention and problem-solving ability;
- Digital modeling of hydrogeological processes fosters critical and spatial thinking;
- The connection between theory and practice is essential for sustainable professional training.

Recommendations for Higher Education Institutions of Kazakhstan:

1. Strengthen methodological training for hydrogeology instructors through national workshops and international internships (e.g., Erasmus+ and UNESCO IHP programs).
2. Upgrade digital and laboratory infrastructure, ensuring access to modern GIS, hydro-modeling, and remote sensing tools.
3. Integrate interdisciplinary modules combining hydrogeology with ecology, environmental management, and sustainability studies.
4. Develop open digital platforms with localized case studies and interactive maps of Kazakhstan's groundwater systems.
5. Support field-based learning through collaboration between universities and regional environmental agencies.

These measures will enhance the quality of hydrogeological education in Kazakhstan and prepare graduates capable of addressing contemporary environmental and water-resource challenges within the framework of sustainable development.

References:

1. Seibert J., Uhlenbrook S., Wagener T. *Hydrology education in a changing world*. // «Hydrology and Earth System Sciences». –2013. –№17(4). –pp. 1393-1403.
2. Сапарбайұлы К. *Геология және гидрогеология негіздері*. –Алматы: Білім, 1996. –296 б.
3. Ережепов Н.Е., Искаков Н.Қ., Мақыжанова А.Т. *Жалпы гидрогеология: оқу құралы*. –Алматы: ҚазҰТУ, 2005. –179 б.
4. Кедров Б.М. *Диалектика естествознания XX века: материя и движение*. –М.:Наука, 1971. –400 с.
5. Достайұлы Ж. *Жалпы гидрология: оқулық*. –Алматы, 1996. –256 б.
6. Веселов В.В., Сыдықов Ж.С. *Гидрогеология Казахстана*. –Алматы, 2004. –484 с.
7. Kolb D.A. *Experiential Learning: Experience as the Source of Learning and Development*. – Englewood Cliffs, NJ: Prentice-Hall, 1984. –256 p.
8. Dewey J. *Experience and Education*. –New York: Macmillan, 1938. –116 p.
9. Manduca C.A., Mogk D.W. *Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences*. // *Geological Society of America Special Paper 486*. –Boulder, CO: Geological Society of America, 2020. –210 p. DOI: 10.1130/SPE486.
10. King C. *Geoscience Education: An Overview of International Trends and Challenges*. // «Journal of Geoscience Education». –2021. –Vol. 69, №2. –pp. 95-108.
11. Сардарова Ж.И., Жұмашева Н.С., Мусағалиева Г.Б. *Педагогтардың цифрлық құзыреттілігі: бүгінгі жағдайы, проблемалары // Абай атындағы ҚазҰПУ-ң Хабаршысы. «Педагогика ғылымдары» сериясы*. –Алматы, 2022. –№1(73). –157-167 бб.

12. Плотников Н.И. Основы гидрогеологии. –Москва: Недра, 1989. –352 с.
13. Gleeson T., Allen D.M., Ferguson G. Teaching hydrogeology: a review of current practice // «Hydrology and Earth System Sciences». –2012. –Vol.16. –pp. 2159-2168. URL: doi:10.5194/hess-16-2159-2012.
14. Jimenez-Martinez J. Improving training in the hydrogeology of volcanic islands // «Procedia – Social and Behavioral Sciences». –2015. –Vol. 191. –pp. 768-771.
15. Editorial: Innovations in remote and online education by hydrologic sciences // «Frontiers in Environmental Science». –2022. –Vol.10. Article 1074801. DOI: 10.3389/fenvs.2022.1074801.
16. Kucher T.A., Fedorenko E.V. Cloud ArcGIS Online as an innovative tool for developing geoinformation competence with future geography teachers // «arXiv preprint». –2019.
17. Elshorbagy A. Model-based learning in hydrology education. // «Hydrology and Earth System Sciences». –2005. –Vol. 9, №1-2. –pp. 127-136. DOI: 10.5194/hess-9-127-2005.

References:

1. Seibert J., Uhlenbrook S., Wagener T. Hydrology education in a changing world. // «Hydrology and Earth System Sciences». –2013. –№17(4). –pp. 1393-1403.
2. Saparbaiuly K. Geologia және гидрогеология негіздері. –Алматы: Білім, 1996. –296 б.
3. Erejepov N.E., Iskakov N.Q., Maqjanova A.T. Jalpy gidrogeologia: oqu qūraly. –Алматы: QazŪTU, 2005. –179 б.
4. Kedrov B.M. Dialektika estestvoznania XX veka: materia i dvijenie. –M.: Nauka, 1971. –400 s.
5. Dostaiuly J. Jalpy gidrologia: oqulyq. –Алматы, 1996. –256 б.
6. Veselov V.V., Sydykov J.S. Gidrogeologia Kazahstana. –Алматы, 2004. –484 с.
7. Kolb D.A. Experiential Learning: Experience as the Source of Learning and Development. – Englewood Cliffs, NJ: Prentice-Hall, 1984. –256 p.
8. Dewey J. Experience and Education. –New York: Macmillan, 1938. –116 p.
9. Manduca C.A., Mogk D.W. Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences. // Geological Society of America Special Paper 486. –Boulder, CO: Geological Society of America, 2020. –210 p. DOI: 10.1130/SPE486.
10. King C. Geoscience Education: An Overview of International Trends and Challenges. // «Journal of Geoscience Education». –2021. –Vol. 69, №2. –pp. 95-108.
11. Sardarova J.Ī., Jūmaşeva N.S., Musagalieva G.B. Pedagogtardyñ sifrlyq qūzyrettiligi: бүgingi jağdaiy, problemalary // Abai atyndaqy QazŪPU-ñ Khabarshysy. «Pedagogika ġylymdary» seriyasy. –Алматы, 2022. –№1(73). –157-167 bb.
12. Plotnikov N.Ī. Osnovy gidrogeologii. –Москва: Nedra, 1989. –352 с.
13. Gleeson T., Allen D.M., Ferguson G. Teaching hydrogeology: a review of current practice // «Hydrology and Earth System Sciences». –2012. –Vol.16. –pp. 2159-2168. URL: doi:10.5194/hess-16-2159-2012.
14. Jimenez-Martinez J. Improving training in the hydrogeology of volcanic islands // «Procedia – Social and Behavioral Sciences». –2015. –Vol. 191. –pp. 768-771.
15. Editorial: Innovations in remote and online education by hydrologic sciences // «Frontiers in Environmental Science». –2022. –Vol.10. Article 1074801. DOI: 10.3389/fenvs.2022.1074801.
16. Kucher T.A., Fedorenko E.V. Cloud ArcGIS Online as an innovative tool for developing geoinformation competence with future geography teachers // «arXiv preprint». –2019.
17. Elshorbagy A. Model-based learning in hydrology education. // «Hydrology and Earth System Sciences». –2005. –Vol. 9, №1-2. –pp. 127-136. DOI: 10.5194/hess-9-127-2005.

МРНТИ 14.35.09

<https://doi.org/10.51889/2959-5762.2025.88.4.019>

Кульбекова А.К.,^{1*}  Изім Т.О.,¹  Бакирова С.А.,²  Кайыр Ж.У.¹ 

¹Казахская национальная академия хореографии, г.Астана, Казахстан

²Казахский национальный Женский педагогический университет, г.Алматы, Казахстан

ДИДАКТИЧЕСКИЕ ОСНОВЫ ФОРМИРОВАНИЯ ПРОФЕССИОНАЛЬНОГО МАСТЕРСТВА У ОБУЧАЮЩИХСЯ НА ХОРЕОГРАФИЧЕСКИХ ФАКУЛЬТЕТАХ

Аннотация

Формирование профессионального мастерства хореографов в вузах предполагает задание его цели в виде итоговой модели специалиста. Реализация задач образовательного процесса в хореографических учебных заведениях определило необходимость обоснования дидактико-теоретических основ подготовки кадров и её конечной цели – формирование профессионального мастерства у обучающихся на основе системного подхода. Таким образом, в работе рассматриваются общие закономерности дидактики и особенности в применении её категорий в контексте становления педагогов-хореографов и их готовности к профессиональной деятельности.