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INTEGRATING INNOVATIVE TEACHING METHODS TO FOSTER STUDENTS' RESEARCH COMPETENCE

Annotation

Continuous reforms in the field of education, focused on the introduction of innovative technologies, create significant difficulties for higher education institutions in the context of the effective development of students' research competence. This problem is particularly acute in interdisciplinary courses such as physico-chemical analysis methods, where students must not only master complex theoretical concepts, but also develop practical laboratory skills, analytical thinking and the ability to solve real scientific problems independently.

The purpose of this study is to bridge the gap between theory and practice in higher education chemistry courses by introducing an integrated educational model aimed at developing students' research skills and learning activities. To solve the tasks set, a new pedagogical strategy has been developed and tested. This strategy describes the combination of a case method with basic project management tools in a mixed learning format. The main objective was to combine theory and practice more effectively and actively involve students in the learning process. The authors used and analyzed mixed methods combining theoretical analysis with quasi-experimental pedagogical intervention to study the effectiveness of an integrated learning model in developing students' research competence in the field of physico-chemical analysis methods. The authors conducted a diagnostic assessment of students' research competence in order to determine the basic levels of motivation.

The model is implemented at the undergraduate level in chemistry courses, mainly in the discipline "Physico-chemical methods of analysis". Students worked in small groups with real scientific cases and completed project tasks, including planning experiments and presenting results. Their learning experience and research skills are assessed before and after the implementation of the model through questionnaires, classroom observations, and analysis of project reports. The results show a marked improvement in the ability to formulate research questions, develop experimental plans, and work with data. In addition, students demonstrated a deeper understanding of physico-chemical analysis methods and greater confidence in applying theoretical knowledge in the laboratory.

Keywords: research competence, case-based learning, project-based learning, physicochemical analytical methods, higher education, laboratory sessions, structural-polyfunctional instructional model

Introduction. In recent years, the development of students' research competence has become an important focus in higher education. This trend is closely linked to global educational reforms and the growing integration of new technologies into academic practice. Universities are now expected not only to transmit disciplinary knowledge but also to foster the skills required for independent inquiry, critical thinking, and creative problem-solving [1]. These expectations reflect broader societal demands for graduates capable of generating knowledge, engaging in interdisciplinary collaboration, and contributing to sustainable development. Within this problem, research competence is recognized as a core dimension of academic excellence, professional readiness, and lifelong learning [2].

In physicochemical analytical methods education, the emphasis on research competence is especially pronounced. Physicochemical analytical methods combine principles from chemistry, physics, and mathematics to explain fundamental mechanisms of molecular and material behavior. It underpins innovations in energy production, materials science, biotechnology, and environmental protection [3]. Consequently, education in this discipline must move beyond rote transmission of formulas and theories to embrace pedagogical approaches that enable students to design experiments, analyze data, and apply knowledge to real-world challenges [4]. However, traditional instruction continues to privilege theoretical exposition over active inquiry and laboratory-based exploration. For example, in surveys of physicochemical analytical methods courses adapted during the COVID-

19 pandemic, students frequently reported that flipped classrooms and peer instruction improved motivation yet did not fully compensate for reduced hands-on experimentation. Similarly, virtual laboratories used as supplements in chemistry education have significantly enhanced conceptual understanding and engagement among pre-service teachers [5].

This imbalance between theory and practice constitutes a persistent pedagogical challenge. Current curricula frequently lack mechanisms to integrate research skill development into physicochemical analytical methods courses. Laboratory sessions, though formally included, are often rigidly scripted, limiting opportunities for students to engage in authentic inquiry or to make independent methodological choices [6]. Assessment practices often focus on memorization and procedural accuracy instead of creativity, experimentation, and reflective analysis. As a result, students may have strong theoretical knowledge but struggle to conduct independent research or show innovative thinking in practical situations.

Recent studies highlight the benefits of innovative teaching methods. These methods include case-based learning, project-based learning, inquiry-based instruction, digital laboratory simulations, and virtual or augmented reality (VR/AR) tools. Such approaches help students deepen their conceptual understanding and strengthen their research skills [7]. Recent studies, like «Teaching chemistry in the metaverse» and «Technology-enhanced learning through virtual laboratories in chemistry education» underline the growing use of virtual and augmented reality tools in chemistry instruction. These technologies help students visualize complex processes and support meaningful learning. Research indicates that using VR, AR, and virtual laboratories can boost student engagement and improve conceptual understanding [8]. However, in courses on physicochemical analytical methods, these approaches are typically examined separately or applied on a limited scale. There is still little systematic research that combines various teaching innovations within one course framework to strengthen students' research skills.

The significance of this research lies in its dual contribution. On a theoretical level, it promotes teaching innovation by introducing a structured, multi-method framework aimed at developing research skills in physicochemical analytical methods education [9]. On a practical level, it offers useful guidance for educators and policymakers looking to reform curricula, laboratory practices, and assessment methods. The findings are expected to inform curriculum design and teaching practices, helping to prepare highly qualified graduates who can engage in independent scientific inquiry and professional innovation.

Accordingly, the study is guided by the following research questions:

1. What are the main challenges in developing students' scientific research skills within physicochemical analytical methods education?
2. How can innovative teaching methods specifically case-based learning, project-based learning and digital laboratory tools be effectively integrated into physicochemical analytical methods curricula?

The cultivation of scientific research competence has become a central priority in higher education as universities align curricula with the demands of knowledge economies and rapidly evolving scientific practices. Research competence is increasingly recognized not only as a marker of academic excellence but also as a prerequisite for innovation, sustainability, and professional adaptability [10]. In the context of physicochemical analytical methods, a discipline that integrates chemistry, physics, and mathematics the acquisition of research skills is particularly significant. Students are expected to design experiments, interpret complex data, and apply theoretical knowledge to authentic problems. This review critically examines existing literature on pedagogical innovations that promote research competence, focusing on case-based learning, project-based learning, inquiry-based instruction, digital laboratory simulations, and immersive technologies.

Research competence has been widely acknowledged as a core educational outcome in science disciplines. As a result, students acquire theoretical knowledge but lack inquiry-oriented abilities. Similarly, Wang demonstrates that assessment practices often prioritize memorization over experimental design, thereby neglecting higher-order thinking and methodological reasoning [11].

For physicochemical analytical methods, these findings highlight the persistent gap between the rhetoric of competence-oriented education and classroom reality.

Methods and materials. This study employed a mixed-methods research design combining theoretical analysis with a quasi-experimental pedagogical intervention to examine the effectiveness of an integrated instructional model in developing students' research competence in physicochemical analytical methods. The research was conducted in three stages.

Stage 1. Diagnostic and Analytical Stage.

At the initial stage, a diagnostic assessment of students' research competence was conducted to identify baseline levels of motivation, inquiry skills, experimental design ability, and data analysis competence. In parallel, a theoretical analysis of contemporary pedagogical approaches was carried out through a review of international and national literature on research competence development, including case-based learning, project-based learning, inquiry-based instruction, digital laboratories, and immersive technologies. This stage provided the conceptual foundation for designing the structural-polyfunctional instructional model.

Stage 2. Experimental Stage.

During the experimental stage, a structural-polyfunctional model integrating case-based learning, project-based learning, digital tools, and immersive technologies was implemented in the educational process. The intervention was conducted over one academic semester within the physicochemical analytical methods course. The instructional activities included research-oriented case analysis, project-based experimental tasks, partial student autonomy in experimental design, and the use of digital simulations and virtual laboratory resources to support conceptual and procedural understanding. The content and functional structure of the proposed model, including its key components, implementation forms, and expected learning outcomes, are presented in Table 1.

Table 1. Structure and components of the structural-multifunctional model

Components of the model	Function Implementation forms	Implementation Forms	Expected Outcomes
Goals and objectives component	Development of students' research skills	Setting learning objectives based on Bloom's taxonomy and a competency-based approach	Increased motivation for research, development of scientific thinking
Evaluation component	Connecting theory and practice	Core topics in physicochemical analytical methods (titrimetry, spectrophotometry, chromatography, etc.)	Deepening of theoretical knowledge, formation of subject-specific understanding
Pedagogical methods component	Organization of active research activities	Case-based learning, project-based learning, inquiry-based learning	Hypothesis formulation, and experimental planning
Learning activity component	Promoting students' active role in learning	Project work, laboratory assignments, and small-scale research projects	Independent work skills, responsibility, scientific autonomy
Learner-centered component	Analysis and improvement of outcomes	Pre-test / post-test, questionnaires,	self-assessment, reflection
Assessment and reflection component	Comprehensive development of research competence	Comparison of experimental and control group results	Increased motivation, experimental skills, and data analysis ability
Learning outcomes component	Organizing active research activities	Case-based learning, project-based learning, and inquiry-based learning	Skills in problem identification, hypothesis formulation, and experimental planning

Source: developed by the authors

The proposed structural-polyfunctional instructional model aims to develop students' scientific research skills in teaching physicochemical analytical methods. The model includes several connected parts, each with its own role but working together as a complete teaching system [12]. The goal-oriented part of the model is based on competency-based education principles. It focuses on improving students' motivation for scientific research activities. The content part combines theoretical knowledge with practical laboratory work. This approach strengthens the link between understanding concepts and applying them in experiments.

Within the pedagogical methods component, case-based learning, project-based learning, and inquiry-based learning approaches are systematically integrated to promote students' active engagement in the research process. The digital component facilitates the visualization of complex physicochemical processes and supports data processing through the use of virtual laboratories and digital simulations.

The activity component transforms students from passive recipients of knowledge into active research agents by engaging them in independent scientific inquiry through project-based and experimental tasks. The assessment and reflection component is directed toward analyzing learning outcomes through formative and summative assessment, reflective activities, and self-evaluation.

As a result, the outcome component of the model ensures a significant improvement in key indicators of students' scientific research competence, including motivation, experimental design skills, data analysis abilities, and scientific thinking.

Stage 3. Evaluation Stage.

The final stage focused on evaluating the effectiveness of the proposed model through a comparison of pre- and post-intervention results between the experimental and control groups.

Participants. The study was conducted at Abai Kazakh National Pedagogical University with fourth-year undergraduate students majoring in chemistry. A total of 60 students aged 19-22 participated in the research. The experimental group consisted of 30 students who were taught using the integrated instructional model, while the control group (n = 30) followed traditional instructional methods. In addition, six faculty members teaching physicochemical analytical methods participated in semi-structured interviews to provide expert insights into existing challenges and instructional practices related to research competence development.

Data Collection Instruments.

Multiple data collection tools were used to ensure methodological triangulation:

- *Research competence questionnaire:* a structured 30-item survey measuring motivation, problem identification, hypothesis formulation, experimental design, data analysis, and research ethics awareness, using a five-point Likert scale.

- *Standardized test tasks:* assessing knowledge of research methodology, information resource use, database searching, and plagiarism awareness, administered before and after the intervention.

- *Semi-structured interviews:* conducted with faculty members to explore perceptions of research competence development and the impact of innovative pedagogical approaches.

- *Document analysis:* including curricula, instructional materials, and student feedback to provide context for the integration of research-focused learning activities.

- *Data analysis:*

Quantitative data were examined with descriptive statistics, paired t-tests, and one-way analysis of variance (ANOVA). This approach helped assess changes in research competence indicators and compare results between the experimental and control groups. The transcription of qualitative interviews was then analysed thematically so as to identify common themes about both types of instructional challenges, as well as what are viewed to be instructional strategies that have proven most effective. By combining qualitative with quantitative analysis, the researchers were able to identify and document validity and reliability of the findings.

Results and their discussion. The study gives a good look at how future teachers can build research skills by using new ways of teaching. The initial phase of the research focused on identifying the overall perspectives, motivation, and readiness of students to engage in research activities. The survey results revealed that a significant proportion of students in both experimental and control

groups demonstrated only moderate motivation toward research at the outset. For example, prior to the intervention, nearly half of the experimental group (46,6%) and 40% of the control group displayed low levels of motivation, with only a negligible proportion of students expressing high motivation (Table 2). This highlights the broader challenge in higher education where students often perceive research as an obligatory academic requirement rather than an integral part of their professional development.

Table 2. Student research motivation (before experiment):

Groups	Levels			Indicators (Quantitative, %)
	Low	Medium	High	
Expert Group (EG)	14 (46,6)	15 (50)	1(3,3)	30 (100)
Corporate Governance (CG)	12 (40)	17 (56,7)	1(3,3)	30 (100)

Source: developed by the authors

Survey answers showed that students thought physicochemical methods were relevant and vital today. But, this belief didn't always lead to them being driven or ready to do their own research. Questions about getting resources, handling time, and knowing current research showed other problems. These results match what's already been written. It says that wanting to learn research is complex and impacted by personal interest, school backing, and teacher input.

Later tests of the students' understanding of research confirmed what we saw earlier. At the start, both groups scored about the same on average, around 59-60%. This shows they both started with similar research skills. After the experimental group used the structural model, their scores went up to an average of 70%, while the control group only reached 65,3%. This difference shows that new teaching methods that mix theory and practice can really help student learning. The model taught students things like how to search databases, avoid plagiarism, and cite sources. It also helped students learn how to think critically about information.

The growth of students' critical thinking abilities was a key result. At the beginning of the experiment, a considerable proportion of students in both groups exhibited low or medium levels of critical analysis. By the end of the intervention, however, 70,5% of students in the experimental group had moved into higher competency levels, while the control group displayed only moderate gains (Table 3). This suggests that structured, multifaceted approaches which combine guided practice, interactive methods, and communicative strategies are especially effective in nurturing higher-order cognitive skills.

Table 3. Results of theoretical knowledge of research among students in EG and CG (before and after the experiment)

	Experimental group			Control group		
	The number of correct answers	%	The number of students	The number of correct answers	%	The number of students
Pre-test	549	61,0	30	540	60,0	30
Post-test	727	80,78	30	635	70,5	30
Total result		19,8		10,5		

Source: developed by the authors

The ability to identify research topics and structure academic work also showed considerable progress in the experimental group. Initially, many students expressed difficulty in organizing their

work and defining clear research objectives, with only a small percentage able to perform these tasks at a high level. Following the intervention, more than two-thirds of students in the experimental group were able to demonstrate advanced competence in these areas, whereas improvements in the control group remained less pronounced. Such findings illustrate the necessity of pedagogical strategies that directly engage students in the process of topic formulation, literature review, and methodological planning rather than focusing solely on theoretical content delivery.

Another critical dimension highlighted by the findings is students' motivation for research after the experimental phase. The data clearly demonstrate that interest in research among the experimental group increased substantially from 33,3% to 65,5%-while the control group saw a smaller rise, from 32,2% to 56,7% (Table 4). This indicates that innovative pedagogical interventions not only enhance technical research skills but also strengthen students' intrinsic motivation. This outcome is of particular importance because motivation is often regarded as the foundation upon which sustainable research competence is built. Without motivation, even technically proficient students may struggle to translate their skills into meaningful scholarly contributions.

Table 4. Dynamics of the formation of students' research skills before and after the experiment

Skills	Level (indicator, quantitative, %)							
	Experimental group			Control group				
		Low	Medium	High	Low	Medium	High	
Research competence in the professional field	Start	14 (46,6)	15 (50,0)	1 (3,33)	11 (36,6)	18 (60,0)	1 (3,33)	
	End	5 (16,6)	21 (73,3)	4 (13,3)	9 (30,0)	20 (66,6)	1 (3,33)	
The ability to determine the structure of the work	Start	13 (43,3)	15 (50,0)	2 (6,67)	12 (40,0)	17 (56,6)	1 (3,33)	
	End	4 (13,3)	24 (80,0)	6 (20,0)	10 (33,3)	17 (56,6)	3 (10,0)	
The ability to find literature sources	Start	16 (53,3)	12 (40,0)	2 (6,67)	18 (60,0)	11(36,6)	1 (3,33)	
	End	9 (30,0)	17 (56,6)	2 (6,67)	11 (36,6)	17 (56,6)	2 (6,67)	
Critical thinking skills	Start	18 (60,0)	11 (36,6)	1 (3,33)	21 (70)	9 (30,0)	-	
	End	6 (20,0)	23 (38,3)	2 (6,67)	9 (30,0)	9 (30,0)	4 (13,3)	
The ability to work with references and the skills to format used literature sources	Start	11 (36,6)	15 (50,0)	4 (13,3)	16 (53,3)	13 (43,3)	1 (46,6)	
	End	3 (10,0)	21 (73,3)	6 (20)	8 (26,6)	20 (66,6)	2 (6,67)	
The ability to identify topics	Start	14 (46,6)	14 (46,6)	2 (6,67)	13 (43,3)	15 (50,0)	2 (6,67)	
	End	5 (16,6)	20 (66,6)	6 (20)	8 (26,6)	17 (56,6)	5 (16,6)	
	Start	86	83	11	91	83	6	
		Average score - 59%			Average score - 60%			
	End	43	138	28	59	120	17	
		Average score - 70%			Average score - 65,3%			

Source: developed by the authors

The findings make it clear that research competence is unlikely to develop through traditional lectures alone. In practice, students need an approach that brings theory and application together, gives them space to reflect on what they are doing, and helps maintain their motivation throughout the learning process.

In general, the results of the study indicate that the use of a structured learning model has a positive impact on the formation of students' research competencies. The increase in the level of theoretical knowledge, the development of critical thinking and the growth of motivation for scientific activity confirm the need to integrate practice-oriented teaching methods into the educational process. The results obtained can be used in the development of educational programs and methodological approaches aimed at developing the research potential of students.

In addition, the results of the study show that the systematic inclusion of students in research activities contributes to the formation of their stable skills in independent search, analysis and interpretation of scientific information. The practical orientation of the proposed model allows

students not only to acquire theoretical knowledge, but also to apply it in the process of completing research assignments.

It should be noted that the development of students' research competencies is one of the key factors in improving the quality of higher education in modern conditions. The formation of students' critical information analysis skills, academic integrity and scientific thinking contributes to their more effective preparation for further professional and scientific activities.

The study assessed changes in the level of students' theoretical knowledge in the field of research before and after the introduction of the proposed pedagogical model. A comparative analysis of the results of the experimental and control groups revealed the dynamics of students' assimilation of research knowledge. The results of this analysis are shown in Figure 1.

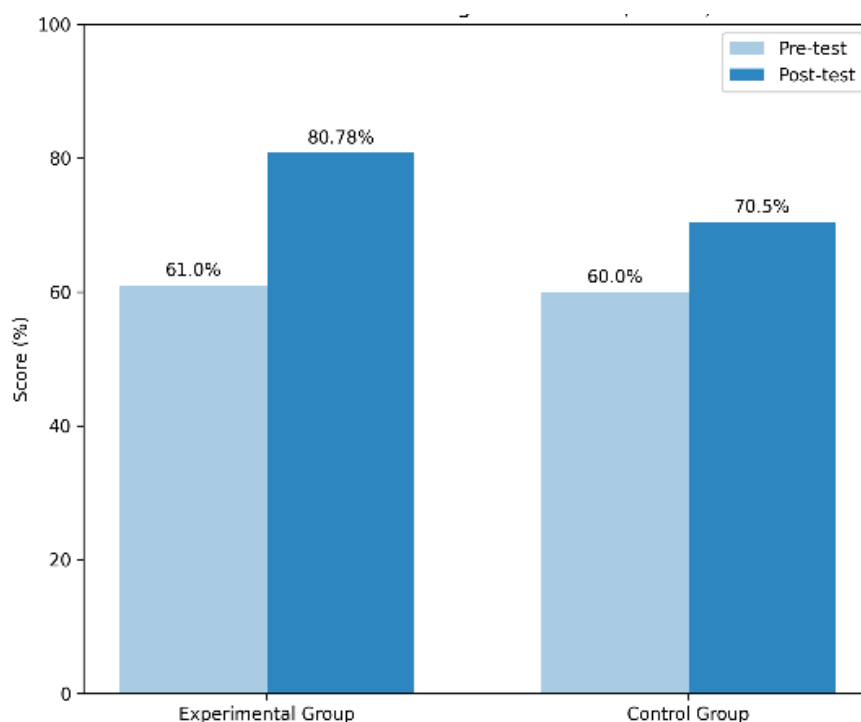


Figure 1. Theoretical knowledge of research

Source: developed by the authors.

Figure 1 shows the change in students' theoretical knowledge of research before and after the experiment. At the beginning, the experimental group scored 61%, while the control group scored 60%, indicating similar initial levels. After the intervention, the experimental group's result increased to 80.78%, whereas the control group reached 70.5%. These results suggest that as theoretical knowledge increases (from 61% to about 80%), students' practical research skills and internal motivation also develop.

Thus, the presented results demonstrate a positive trend in the level of theoretical knowledge of students, especially in the experimental group. The data obtained indicate that the application of the proposed learning model contributes to a more effective assimilation of research knowledge in comparison with traditional teaching methods. The increase in the level of theoretical training of students is also accompanied by the development of their practical research skills and increased motivation for scientific activity.

Conclusion. The findings of the study indicate that innovative teaching approaches can significantly enhance students' research competence, critical thinking, and interest in scientific inquiry. In the course Physical Chemistry Analysis Methods, the multifunctional model integrating project-based and inquiry-oriented learning proved to be more effective than traditional instruction. Students in the experimental group not only improved their ability to plan and conduct research, but

also developed a sustained intrinsic interest in scientific investigation. As a result, they demonstrated greater initiative and engagement throughout the learning process.

Based on the obtained data, it can be observed that when learning activities are organized in a systematic and deliberate manner, students' research skills and inquiry-oriented thinking gradually develop. This shift from teacher-centered, passive instruction to active, research-oriented learning appears to be an important direction for contemporary higher education. Within this transformation, the role of the educator becomes particularly significant: the teacher is not merely a transmitter of knowledge, but also a facilitator of reflection, curiosity, and creativity.

From a practical perspective, these results hold important implications for professional development and curriculum improvement. The integration of project-based and inquiry-oriented approaches enables future educators to create learning environments that foster independence, critical analysis, and sustained scientific engagement. Overall, the study demonstrates that student-centered innovative strategies not only strengthen research skills but also deepen students' understanding of the value of scientific inquiry for their academic and professional development.

The quantitative results of the study also confirm the effectiveness of the proposed learning model. In particular, the level of theoretical knowledge of the students in the experimental group increased from 61% at the initial stage to 80,78% after the experiment, while in the control group the increase was from 60% to 70,5%. A similar positive trend was observed in the level of students' research motivation: the proportion of students showing a high interest in scientific activity in the experimental group increased from 33.3% to 65,5%, while in the control group this indicator increased from only 32,2% to 56,7%. In addition, about 70,5% of the students in the experimental group demonstrated a higher level of development of critical thinking and research competencies by the end of the experiment. These results in percentage terms clearly confirm the effectiveness of the implementation of an innovative pedagogical learning model.

Thus, the results obtained indicate that the introduction of project-based research teaching methods contributes to a more effective formation of students' research culture and can be recommended for wider application in the higher education system.

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СТУДЕНТТЕРДІҢ ЗЕРТТЕУ ҚҰЗЫРЕТТІЛІГІН ДАМУ ТУРАСЫНДА ИННОВАЦИЯЛЫҚ ОҚЫТУ ӘДІСТЕРІН БІРІКТІРУ

Аңдатпа

Инновациялық технологияларды енгізуге бағытталған білім беру саласындағы үздіксіз реформалар студенттердің зерттеу құзыреттілігін тиімді дамыту контекстінде жоғары оқу орындары үшін елеулі қиындықтар туғызады. Бұл мәселе әсіресе физика-химиялық талдау әдістері сияқты пәнаралық курстарда айқын көрінеді, мұнда студенттер күрделі теориялық тұжырымдамаларды игеріп қана қоймай, сонымен қатар практикалық зертханалық дағдыларды, аналитикалық ойлауды және нақты ғылыми мәселелерді өз бетінше шешу қабілетін қалыптастыруы керек.

Бұл зерттеудің мақсаты студенттердің зерттеу дағдылары мен оқу белсенділігін дамытуға бағытталған интеграцияланған білім беру моделін енгізу арқылы жоғары білім химиясы курстарындағы теория мен практика арасындағы алшақтықты жою болып табылады. Қойылған міндеттерді шешу үшін жаңа педагогикалық стратегия әзірленіп, сынақтан өткізілді. Бұл стратегияда аралас оқыту форматы шеңберінде кейс-әдісті жобаларды басқарудың негізгі құралдарымен үйлестіру сипатталған. Негізгі міндет теория мен практиканы тиімдірек байланыстыру және студенттерді оқу процесіне белсенді тарту болды. Зерттеуде физика-химиялық талдау әдістері саласындағы оқушылардың зерттеу құзыреттілігін дамытудағы интеграцияланған оқыту моделінің тиімділігін зерттеу үшін теориялық талдауды квази-эксперименттік педагогикалық араласумен біріктіретін аралас әдістерді авторлар қолданды және талдады. Авторлар мотивацияның негізгі деңгейлерін анықтау үшін студенттердің зерттеу құзыреттілігіне диагностикалық бағалау жүргізді.

Модель негізінен «физика-химиялық талдау әдістері» пәні бойынша химия курстарында бакалавриат деңгейінде енгізілген. Студенттер нақты ғылыми жағдайлары бар шағын топтарда жұмыс істеді және эксперименттерді жоспарлау мен нәтижелерді ұсынуды қамтитын жобалық тапсырмаларды орындады. Олардың оқу тәжірибесі мен зерттеу дағдылары сауалнама, аудиториялық бақылау және жобалық есептерді талдау арқылы модельді енгізгенге дейін және одан кейін бағаланады. Нәтижелер зерттеу сұрақтарын тұжырымдау, эксперименттік жоспарлар жасау және деректермен жұмыс істеу қабілетінің айтарлықтай жақсарғанын көрсетеді. Сонымен қатар, студенттер талдаудың физика-химиялық әдістерін тереңірек түсінетіндігін және зертханалық жағдайда теориялық білімді қолдануда үлкен сенімділік танытты.

Түйінді сөздер: зерттеушілік құзыреттілік, кейс-әдіс, жобалық оқыту, физикохимиялық талдау әдістері, жоғары білім, зертханалық оқытулар, құрылымдық-көпфункционалды оқыту моделі.

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ИНТЕГРАЦИЯ ИННОВАЦИОННЫХ МЕТОДОВ ОБУЧЕНИЯ ДЛЯ РАЗВИТИЯ ИССЛЕДОВАТЕЛЬСКОЙ КОМПЕТЕНТНОСТИ СТУДЕНТОВ

Аннотация

Непрерывные реформы в сфере образования, ориентированные на внедрение инновационных технологий, создают существенные трудности для высших учебных заведений в контексте эффективного развития исследовательской компетентности студентов. Особенно остро данная проблема проявляется в междисциплинарных курсах, таких как физико-химические методы анализа, где обучающиеся должны не только освоить сложные теоретические концепции, но и сформировать практические лабораторные навыки, аналитическое мышление и способность самостоятельно решать реальные научные задачи.

Цель данного исследования заключается в устранении разрыва между теорией и практикой в курсах химии высшего образования посредством внедрения интегрированной образовательной модели, направленной на развитие исследовательских навыков и учебной активности студентов. Для решения поставленных задач разработана и апробирована новая педагогическая стратегия. В данной стратегии описано сочетание кейс-метода с базовыми инструментами управления проектами в рамках смешанного формата обучения. Основная задача заключалась в более эффективном соединении теории и практики и активном вовлечении студентов в учебный процесс. В исследовании использованы и проанализированы авторами смешанные методы, сочетающие теоретический анализ с квазиэкспериментальным педагогическим вмешательством, для изучения эффективности интегрированной модели обучения в развитии исследовательской компетентности учащихся в области физико-химических методов анализа. Авторами проведена диагностическая оценка исследовательской компетентности студентов, чтобы определить базовые уровни мотивации.

Модель внедрена на уровне бакалавриата в курсах химии, преимущественно по дисциплине «Физико-химические методы анализа». Студенты работали в малых группах с реальными научными кейсами и выполняли проектные задания, включающие планирование экспериментов и представление результатов. Их учебный опыт и исследовательские навыки оценены до и после внедрения модели посредством анкетирования, аудиторных наблюдений и анализа проектных отчетов. В результатах показаны заметное улучшение способности формулировать исследовательские вопросы, разрабатывать экспериментальные планы и работать с данными. Кроме того, студентами продемонстрированы более глубокое понимание физико-химических методов анализа и большую уверенность при применении теоретических знаний в лабораторных условиях.

Ключевые слова: исследовательская компетентность, кейс-метод, проектное обучение, физико-химические методы анализа, высшее образование, лабораторные занятия, структурно-многофункциональная модель обучения.

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