

UDC 378.147:615.1:001.8

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To cite this article: Pushkarova Ya., Reva T., Zaitseva G., Stuchynska N. (2026). An integrated pedagogical model for development of research competence in pharmacy education. *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 2, 221–229, doi: <https://doi.org/10.32782/2522-9680-2026-2-221>

AN INTEGRATED PEDAGOGICAL MODEL FOR DEVELOPMENT OF RESEARCH COMPETENCE IN PHARMACY EDUCATION

Relevance. Contemporary pharmaceutical education is aimed at preparing professionals capable of scientific analysis of professional problems, critical interpretation of research findings, and well-reasoned decision-making in pharmaceutical practice. Under these conditions, research competence is regarded as an integral outcome of professional training of future masters of pharmacy, combining theoretical knowledge, research skills, value orientations, and reflective abilities.

Purpose. The purpose of this study is to substantiate the theoretical and methodological foundations for the formation of research competence in future masters of pharmacy by defining its structure, characterizing the interrelationships between its components, and outlining pedagogical conditions and diagnostic approaches to its assessment.

Materials and methods. The study presents an integrated pedagogical model developed through analysis, comparison, and synthesis of contemporary research in higher education pedagogy and pharmaceutical education.

Results. Research competence is conceptualized as a multidimensional structure comprising cognitive, motivational-value, operational-activity, and reflexive-evaluative components. The proposed model integrates competency-based, project-based, and problem-based approaches, along with research ethics and scientific mentorship, as key pedagogical conditions for competence formation. A system of diagnostic methods (testing, questionnaires, structured observation, case-based tasks, and portfolio assessment) is proposed and theoretically aligned with the respective components of competence to enable comprehensive monitoring of its development.

Conclusions. The integrated pedagogical model systematizes approaches to the formation and assessment of research competence in pharmacy master's programs and provides a conceptual basis for its implementation in the educational process and for further empirical investigation.

Key words: research activity, pharmaceutical education, competency-based education, diagnostic methods, pedagogical model.

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Бібліографічний опис статті: Пушкарьова Я., Рева Т., Зайцева Г., Стучинська Н. (2026). Інтегрована педагогічна модель розвитку дослідницької компетентності у фармацевтичній освіті. *Фітотерапія. Часопис*, 2, 221–229, doi: <https://doi.org/10.32782/2522-9680-2026-2-221>

ІНТЕГРОВАНА ПЕДАГОГІЧНА МОДЕЛЬ РОЗВИТКУ ДОСЛІДНИЦЬКОЇ КОМПЕТЕНТНОСТІ У ФАРМАЦЕВТИЧНІЙ ОСВІТІ

Актуальність. Сучасна фармацевтична освіта спрямована на підготовку фахівців, здатних до наукового аналізу професійних проблем, критичного осмислення результатів досліджень та обґрунтованого прийняття рішень у сфері фармацевтичної практики. За цих умов дослідницька компетентність розглядається як інтегральний результат професійної підготовки майбутніх магістрів фармації, що поєднує систему теоретичних знань, дослідницьких умінь, ціннісних орієнтацій і рефлексивних здатностей.

Мета роботи – обґрунтувати теоретико-методологічні засади формування дослідницької компетентності майбутніх магістрів фармації шляхом визначення її структури, характеристики взаємозв'язків між компонентами, окреслення педагогічних умов і діагностичних підходів до її оцінювання.

Матеріали та методи. У дослідженні представлено інтегровану педагогічну модель, розроблену на основі аналізу, порівняння й узагальнення сучасних наукових праць у галузі педагогіки вищої школи та фармацевтичної освіти.

Результати дослідження. Дослідницька компетентність визначена як багатовимірна структура, що містить когнітивний, мотиваційно-ціннісний, операційно-діяльнісний і рефлексивно-оцінювальний компоненти. Запропонована модель інтегрує компетентнісний, проєктно- та проблемно-орієнтований підходи, елементи дослідницької етики та наукового наставництва як педагогічні умови формування компетентності. Визначено систему діагностичних методів (тестування, анкетування, структуроване спостереження, кейс-метод, портфоліо), теоретично співвіднесених із відповідними компонентами компетентності та спрямованих на комплексне відстеження її розвитку.

Висновки. Інтегрована педагогічна модель систематизує підходи до формування й оцінювання дослідницької компетентності у програмах підготовки магістрів фармації, створює концептуальну основу для її впровадження в освітній процес і подальшого емпіричного вивчення.

Ключові слова: дослідницька діяльність, фармацевтична освіта, компетентнісний підхід, методи діагностики, педагогічна модель.

Introduction. Modern pharmaceutical education is increasingly oriented towards cultivating students' capabilities for scientific inquiry, critical thinking and evidence-based decision-making. These skills are essential for preparing future masters of pharmacy to navigate the complexities of pharmaceutical practice. Within this context, research competence is recognized as a foundational characteristic of professional training, encompassing not only theoretical knowledge, but also practical research skills and methodological awareness (Murry et al., 2024; Roman, 2021). Contemporary pharmacy education emphasizes the need for graduates who are capable not only of applying established knowledge, but also of critically analyzing scientific data, designing studies and interpreting research outcomes in professional contexts.

International studies highlight the growing role of research competence as a core element of competency-based pharmacy education. The review by Katoue and Schwinghammer demonstrates that modern pharmacy curricula are progressively oriented toward clearly defined professional competencies, including the ability to conduct and interpret research as an essential component of evidence-based pharmaceutical practice (Katoue & Schwinghammer, 2020). Similarly, ElKhalifa et al. conducted a scoping review of MSc and PhD pharmacy programs and concluded that structured development of research competencies requires targeted curricular elements, including research methodology courses, supervised research projects and specific assessment strategies (ElKhalifa et al., 2024). These findings confirm that research competence is not an auxiliary skill but an integral learning outcome within advanced pharmacy training.

A number of studies focus on defining the structure and indicators of research competence in the context of pharmaceutical and health professions education. Yan et al. proposed a competency indicator system for pharmacists based on Delphi and analytic hierarchy process methods, identifying cognitive, analytical and communication dimensions necessary for effective research activity (Yan et al., 2025). In parallel, the systematic review by Ianni et al. analyzed assessment approaches for research competencies among clinical investigators, emphasizing the need for multidimensional evaluation tools that capture both knowledge and practical research performance (Ianni et al., 2021). Vázquez-Rodríguez further systematized instruments for measuring research competence in educational settings, demonstrating that comprehensive assessment requires a combination of quantitative and qualitative methods rather than reliance on single testing formats (Vázquez-Rodríguez, 2024).

Another important direction concerns the ethical and cultural dimensions of research training in pharmacy programs. Ahmed and Nebeker revealed gaps in the integration of research ethics education in pharmacy master's programs and stressed the importance of embedding ethical standards and responsible research conduct into professional preparation (Ahmed & Nebeker, 2021). In addition, Murry et al. noted that continuous professional development in pharmacy increasingly depends on the ability to engage in scientific inquiry and critically evaluate emerging pharmaceutical evidence, further reinforcing the relevance of research competence formation at the master's level (Murry et al., 2024).

Alongside these pharmacy-focused studies, broader pedagogical research conceptualizes research competence as a multidimensional construct that includes cognitive, motivational, operational and reflective components. George-Reyes et al. associated research competencies with complex thinking and Education 4.0, underlining their integrative nature in higher education (George-Reyes et al., 2023). Roman emphasized the role of research competence in enhancing institutional effectiveness and academic performance (Roman, 2021), while Mahasneh highlighted the potential of e-portfolio models for documenting and developing students' research achievements (Mahasneh, 2020). Project-based learning, analyzed by Kokotsaki et al., has also been widely recognized as an effective pedagogical strategy for engaging students in authentic research tasks and fostering analytical and problem-solving abilities (Kokotsaki et al., 2016).

In the Ukrainian scientific context, the problem of forming research competence among future pharmaceutical specialists has been addressed in several pedagogical studies. Of particular relevance is the work of Omelchenko, who developed a model for the formation of research competence of future specialists in industrial pharmacy (Omelchenko, 2025). The author substantiated the structural components of research competence and described pedagogical stages of its development within professional training. This study significantly contributes to understanding the processual organization of competence formation in pharmacy education; however, it is primarily focused on the industrial pharmacy profile and emphasizes organizational and methodological aspects of training.

Furthermore, the theoretical and didactic foundations of research competence formation in higher education are elaborated in the work of Levchenko, who conceptualizes research competence as a complex integrative construct formed through the interaction of cognitive, activity-based and reflective components (Levchenko, 2025).

Although this study is not limited to pharmacy education, its conclusions are methodologically relevant for substantiating pedagogical conditions and instructional strategies that ensure systematic development of students' research abilities within professional training programs.

Thus, the analysis of Ukrainian and international literature indicates a lack of an integrated theoretical and methodological model that simultaneously defines the structural components of research competence, substantiates pedagogical conditions for its formation and aligns them with appropriate diagnostic methods within the context of modern master's level pharmacy education. This gap determines the relevance of developing an integrated pedagogical model that synthesizes these elements into a coherent framework for research competence formation among future masters of pharmacy.

The aim of this paper is to substantiate the theoretical and methodological foundations for the formation of research competence in future masters of pharmacy by defining its structure, characterizing the interrelationships between its components, and outlining pedagogical conditions and diagnostic approaches to its assessment.

Materials and methods. The integrated pedagogical model presented in this paper was developed through a comprehensive theoretical analysis and synthesis of contemporary scientific literature in pharmaceutical education.

Results and their discussion

Concept and structure of research competence

Research competence in pharmacy education is defined as an integrated professional attribute reflecting a future master of pharmacy's readiness to conduct scientific inquiry within pharmaceutical sciences. It encompasses the ability to design and perform experimental and analytical studies related to medicinal substances, dosage forms, medicinal plant raw materials and biologically active substances of natural origin, critically evaluate pharmaceutical data, apply appropriate research methodologies and interpret results in accordance with the principles of evidence-based pharmacy and research ethics. Thus, research competence integrates theoretical knowledge of pharmaceutical disciplines with practical skills in experimental design, data analysis and scientific communication, ensuring preparedness for solving research and professional tasks specific to pharmaceutical practice and development.

Based on the analysis of recent studies (ElKhalifa et al., 2024; Yan et al., 2025; Roman, 2021; George-Reyes et al., 2023) four key components of research competence essential for future masters of pharmacy are identified: cognitive, motivational-value, operational-activity and reflexive-evaluative. Together, these form an

integrated system of knowledge, skills, motivations and abilities necessary for effective scientific work.

The cognitive component involves knowledge of research methodology within pharmaceutical disciplines, including experimental design, analytical validation, pharmacognostic and phytochemical methods, as well as biopharmaceutical and technological approaches to studying medicinal products of synthetic and natural origin. It enables students to critically evaluate scientific publications in pharmacy, justify methodological choices and interpret experimental data.

The motivational-value component reflects a stable orientation toward scientific inquiry in pharmaceutical practice, awareness of the importance of evidence-based decision-making in drug development and use, and adherence to principles of research ethics and academic integrity in pharmaceutical investigations.

The operational-activity component encompasses practical research skills specific to pharmacy education: formulation of research problems related to medicinal products; selection of appropriate analytical, pharmacognostic and technological methods; experimental activities in pharmaceutical research; statistical processing of results and preparation of scientific reports in accordance with pharmaceutical research standards.

The reflexive-evaluative component ensures the ability to critically assess the validity and reliability of obtained pharmaceutical results, identify methodological limitations, adjust research strategies and plan further experimental or analytical investigations in the context of professional pharmaceutical tasks.

Table presents a description of these core components, including examples of their manifestations in educational and practical activities.

Pedagogical conditions for forming research competence

The development of research competence in future masters of pharmacy requires a methodically structured educational environment. In this study, pedagogical conditions are understood as a set of interconnected organizational, methodological and content-related factors that ensure the systematic development of research competence within pharmacy master's training. These pedagogical conditions encompass: (1) competency-based curriculum design oriented toward research outcomes; (2) organization of research-oriented project activities; (3) systematic use of problem-based and case-based professional situations; (4) integration of research methodology, academic writing and pharmaceutical ethics into the curriculum; and (5) individualized scientific supervision and mentorship supporting students' research development.

A competency-based approach in pharmacy education aligns learning outcomes, instructional strategies

Table

Description of four fundamental components of research competence

Component	Description	Examples of Manifestation
Cognitive	Knowledge of research methodology within pharmaceutical sciences, including experimental design, analytical validation and biopharmaceutical approaches	Critical analysis of pharmaceutical research articles; justification of analytical and technological methods; interpretation of experimental data on medicinal substances and dosage forms
Motivational-value	Orientation toward scientific inquiry in pharmaceutical practice and awareness of the role of evidence-based decision-making and research ethics	Engagement in research projects on drug development or quality control; adherence to research ethics and academic integrity in pharmaceutical investigations
Operational-activity	Practical skills in planning and conducting pharmaceutical research, selecting analytical and technological methods and processing experimental data	Designing studies on medicinal products; performing laboratory experiments; statistical analysis of pharmaceutical data; preparation of research reports
Reflexive-evaluative	Ability to critically evaluate the validity and reliability of pharmaceutical research results and adjust research strategies	Critical appraisal of obtained experimental results; identification of methodological limitations; planning further pharmaceutical investigations

and assessment methods with clearly defined research competencies required for professional pharmaceutical practice. Within master's programs in pharmacy, this approach emphasizes students' readiness to design and conduct experimental and analytical studies involving diverse pharmaceutical objects, apply validated research methodologies, interpret pharmaceutical data and justify evidence-based decisions. Consequently, competency-based education shifts the focus from reproduction of theoretical knowledge to the development of research abilities directly related to pharmaceutical analysis, technology, evaluation of drug quality and efficacy.

Project-based learning at the master's level engages students in research projects focused on pharmaceutical problems, including investigation of medicinal substances, analysis of drug formulations, validation of analytical methods and evaluation of experimental data. Participation in such projects fosters autonomy, responsibility, critical and analytical thinking, as well as the ability to plan and implement research procedures in accordance with the standards of pharmaceutical science. This approach ensures the integration of theoretical knowledge from pharmaceutical disciplines with practical research experience, thereby strengthening the operational and cognitive components of research competence.

Problem-based learning and case-based methods in pharmacy education simulate authentic professional and research situations related to the development, analysis and safe use of medicinal products. Such cases may involve interpretation of experimental data on drug stability, selection of optimal technology for dosage form production, evaluation of bioavailability or analysis of adverse drug reactions based on clinical and pharmaceutical evidence. Working with complex and uncertain pharmaceutical scenarios promotes flexible thinking, evi-

dence-based decision-making and critical evaluation of research results, thereby strengthening both the cognitive and operational components of research competence.

Systematic integration of research methodology, academic writing, pharmaceutical ethics and principles of responsible research into the curriculum is essential for the formation of research competence in future masters of pharmacy (Ahmed & Nebeker, 2021). Particular emphasis is placed on ethical aspects of pharmaceutical investigations, including reliability of experimental data, transparency of analytical procedures and responsibility for conclusions that may influence the quality, safety and efficacy of medicinal products. Embedding these principles into the educational process fosters value-based orientations and strengthens the motivational-value component of research competence.

An essential organizational condition for sustaining students' research activity is scientific supervision and mentorship in pharmacy education. Scientific supervision and mentorship in pharmacy education provide individualized guidance throughout all stages of research activity, from problem formulation and experimental design to data interpretation and presentation of pharmaceutical findings. This support fosters methodological rigor, professional responsibility and reflective-evaluative skills necessary for conducting valid and ethically sound pharmaceutical research (Tokalić, 2023).

Together, these pedagogical conditions form an integrated system. When systematically applied, they create a supportive educational environment conducive to the sustainable formation of research competence in future masters of pharmacy.

Diagnostic methods for assessing research competence

The practice-oriented nature of pharmacy education requires diagnostic tools that assess not only theoretic-

cal knowledge but also students' ability to apply experimental and analytical methods used in pharmaceutical research. Such diagnostics should evaluate competencies related to investigation of medicinal substances and dosage forms, processing and statistical interpretation of pharmaceutical data, and performance of laboratory procedures in accordance with methodological and quality requirements of pharmaceutical science.

Testing serves as a primary tool for assessing the cognitive component of research competence in pharmacy students, as it allows evaluation of their knowledge of research methodology applied in pharmaceutical sciences, principles of analytical method validation and interpretation of experimental data. Such tests should focus not only on theoretical recall but also on understanding of pharmaceutical research logic, methodological justification of chosen approaches and critical analysis of obtained results (Nizhenkovska et al., 2024). Test results may be interpreted according to three levels of cognitive component formation. A low level is characterized by fragmented knowledge of research concepts and inability to justify methodological decisions. A medium level reflects partial understanding of research logic with noticeable gaps in methodological reasoning. A high level indicates systematic mastery of research terminology, principles of analytical method validation and the ability to critically interpret pharmaceutical experimental data.

Questionnaires and surveys are effective tools for diagnosing the motivational-value component of research competence (Manstein et al., 2023). They reveal students' interest in scientific research, attitudes toward research activities, self-assessment of skills and project participation experience. Administering questionnaires dynamically (at the beginning, midpoint and end of a course or program) enables monitoring individual learner progress. Results require qualitative analysis considering the educational context.

Structured observation is an effective method for diagnosing the operational-activity component of research competence in pharmacy education, particularly during laboratory classes and experimental research activities. Instructors observe how students formulate research objectives related to medicinal substances or dosage forms, select and justify appropriate analytical or technological methods, perform experimental procedures, work with laboratory and analytical equipment, maintain research protocols and interpret pharmaceutical results. This approach allows evaluation of methodological consistency, critical thinking and reliability of experimental data.

The results of structured observation may be interpreted according to three levels of operational-activity

component formation. A low level is characterized by students' dependence on constant guidance, frequent procedural errors and insufficient understanding of methodological links between research stages. A medium level reflects partial independence in performing experimental procedures with occasional mistakes and limited justification of chosen methods. A high level indicates the ability to independently plan and conduct pharmaceutical research, critically analyze experimental errors and substantiate methodological decisions in accordance with the requirements of pharmaceutical science.

Case method is an effective tool for assessing students' ability to apply research knowledge in complex and uncertain pharmaceutical contexts. In pharmacy education, cases may involve analysis of experimental data on drug stability, selection and justification of technological approaches to dosage form development, evaluation of bioavailability or interpretation of adverse drug reactions based on clinical and pharmaceutical evidence (Pushkarova & Zaitseva, 2022). Solving such research-oriented cases requires identification of key scientific problems, critical analysis of pharmaceutical data and justification of evidence-based decisions, which directly reflects the operational-activity component of research competence.

The results of case analysis may be interpreted at three levels of operational-activity component formation. A low level is characterized by superficial interpretation of the case, incomplete identification of research problems and lack of justified solutions. A medium level reflects the ability to identify key pharmaceutical problems and propose basic solutions without deep analytical substantiation. A high level demonstrates comprehensive problem identification, critical analysis of pharmaceutical data and development of logically consistent and evidence-based decisions that consider potential risks and alternative strategies.

Portfolios serve to document and analyze individual progress in research competence among future masters of pharmacy by capturing both the results and the process of research activity (Mahasneh, 2020). They may include reports on experimental pharmaceutical studies, analytical validation results, research protocols, scientific presentations, posters and participation in conferences. As a diagnostic tool, the portfolio primarily supports the assessment of the reflexive-evaluative component of research competence, as it reflects students' ability to critically analyze their own research experience, justify methodological decisions and evaluate the reliability of obtained results. At the same time, the portfolio also indirectly demonstrates the development of the operational-activity component

through documented research outputs and experimental procedures. Process-oriented elements, such as laboratory research diaries, methodological justifications of selected approaches and reflective reports on experimental findings, are particularly important for developing the reflexive-evaluative component. A dynamic portfolio enables continuous monitoring of students' research development and provides personalized feedback aimed at improving the quality and reliability of pharmaceutical research.

Thus, the proposed integrated pedagogical model offers a structured, multidimensional view of research competence formation at the master's level, highlighting the dynamic interaction of cognitive, motivational-value, operational-activity and reflexive-evaluative components. Each component of research competence is supported by corresponding pedagogical conditions and diagnostic methods. Such alignment ensures coherence between the structure of research competence, educational strategies used for its formation and tools applied for its assessment in pharmacy master's programs. Fig. illustrates research competence as a multidimensional construct, while pedagogical conditions function as systemic factors fostering the development of all components throughout the program. Key pedagogical approaches include competency-based education, project- and problem-based learning and scientific mentorship, which collectively support the formation of research competence. A notable strength of the model is

the explicit alignment of diagnostic methods with each competence component, enhancing evaluation coherence and supporting quality assurance in pharmaceutical education.

Unlike existing studies that predominantly focus on individual aspects of research competence (competency-based curricula, indicator systems, ethical training, or assessment instruments), the proposed model integrates cognitive, motivational-value, operational-activity and reflexive-evaluative components within a unified pedagogical structure. This integration ensures consistency between the competence structure, educational strategies and assessment methods in master's level pharmacy education. The model is specifically tailored to the pharmaceutical context, addressing the unique requirements of mastering research skills in pharmaceutical sciences, analytical validation and professional decision-making in professional practice. The study therefore presents a theoretically substantiated and methodologically structured model that systematizes the formation and evaluation of research competence in pharmacy education.

The practical significance of the model lies in its use for designing and improving research-oriented pharmacy master's curricula. It enables educators to systematically plan and monitor the development of students' abilities to formulate research problems, analyze pharmaceutical data, interpret experimental results and present scientific findings in professional contexts. The model may be used in organizing students' research work, supervising

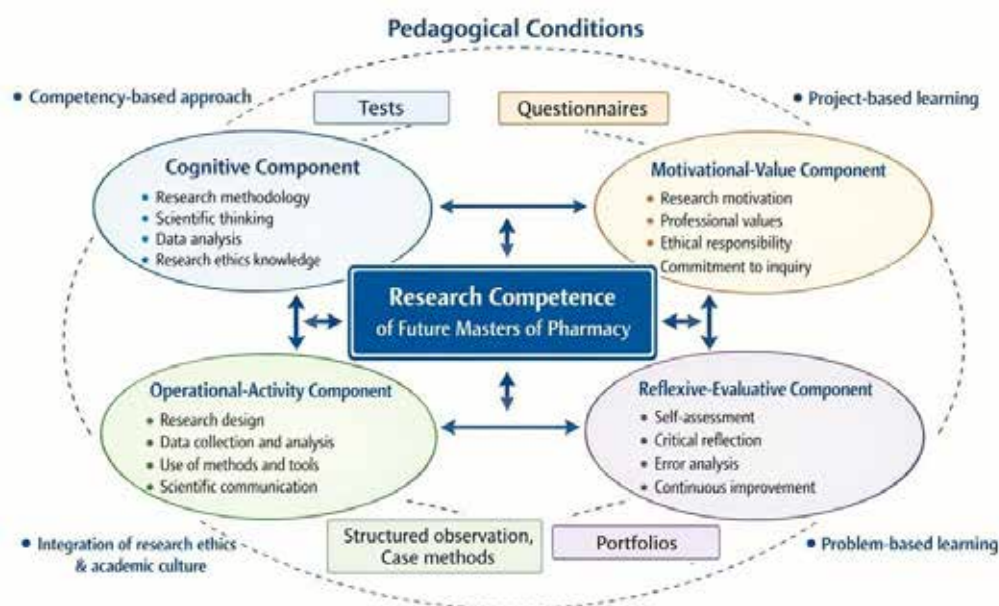


Fig. Integrated pedagogical model of research competence formation in pharmacy education

master's theses and integrating research-oriented tasks into professional pharmaceutical disciplines.

Implementation of the model in pharmacy master's programs may involve several steps. Research-oriented tasks and mini-projects may be integrated into different courses to support the development of cognitive and operational components. The curriculum may also include elements of research methodology, academic writing and pharmaceutical research ethics to strengthen the motivational-value component. In addition, diagnostic monitoring using testing, structured observation, case-based tasks and portfolio assessment can be applied at different stages of training to track students' research competence development and provide feedback.

Conclusions. The study substantiates the importance of research competence as a key educational

outcome in training future masters of pharmacy and presents an integrated pedagogical model for its development in pharmacy master's education. Research competence is conceptualized as a multi-dimensional construct comprising cognitive, motivational-value, operational-activity and reflexive-evaluative components. Based on the synthesis of contemporary pedagogical and pharmaceutical education literature, the model outlines the competence structure, relevant pedagogical conditions and a set of diagnostic methods theoretically aligned with these components. The proposed model systematizes approaches to research competence formation in pharmacy master's programs and provides a conceptual basis for its further practical implementation and empirical validation.

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Стаття надійшла до редакції 17.11.2025

Стаття прийнята до друку 20.04.2026

Дата публікації (оприлюднення) статті 03.09.2026

Conflict of interests: There is no conflict of interests related to this research study.

Authors' contribution:

Pushkarova Ya.M. – conceptualized the theoretical framework of research competence, conducted a comprehensive systematic literature review and substantially contributed to drafting and revising the manuscript;

Reva T.D. – contributed to the analysis and description of pedagogical conditions and diagnostic methodologies, performed analytical interpretation of sources and assisted in manuscript preparation;

Zaitseva G.M. – conducted conceptual analysis of research competence components, performed comparative analysis of existing pedagogical models and supported manuscript refinement;

Stuchynska N.V. – supervised the research process, provided methodological guidance and critically revised the manuscript for important intellectual content.

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