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RESEARCH ACTIVITIES IN THE PROFESSIONAL TRAINING OF STUDENTS IN ENGINEERING AND PEDAGOGICAL SPECIALITIES

Kateryna Lukashenko

Research Fellow, Department of Pedagogical Source Studies, V. O. Sukhomlynskyi State Scientific and Educational Library of Ukraine, https://orcid.org/0000-0002-4457-4423, e-mail: berezanskaya1994@gmail.com

Abstract

*Background***.** The professional development of students in engineering and pedagogical specialities takes place through the integration of technical, technological, and pedagogical training. This requires students not only to acquire established knowledge but also to identify professional problems independently, select appropriate research methods, substantiate solutions, and evaluate their effectiveness. In this context, research activities serve as a means of professionalisation by combining cognitive engagement, the practical solution of professional tasks, motivation for self-development, scholarly communication, and reflection.

*Objective***.** To provide a theoretical rationale for the role of research activities in the professional training of students in engineering and pedagogical specialities.

*Methods***.** This theoretical and analytical study employed comparative and systemic-functional analyses of scholarly works, as well as the systematisation and synthesis of conceptual principles concerning the development of professional competence, orientation, and identity among students in engineering and pedagogical specialities. A descriptive comparison was made of aggregated empirical data provided by Dragomanov Ukrainian State University on the publication activity of students at the Faculty of Technology and Design from 2022 to 2026. Absolute values and changes in the proportional share of publications in engineering and technology—covering ICT, industrial engineering, materials science, automation, and design—were analysed without drawing individual-level causal inferences.

*Results***.** The professional-development potential of student research activities was shown to be realised through the interaction of cognitive-methodological, professional-practical, motivational-value, and reflective-communicative mechanisms. The findings support combining educational research tasks in professional disciplines, research components of placements and projects, participation in research groups and laboratories, conference involvement, and the preparation of publications. Between 2022 and 2026, 100 of 149 student publications addressed engineering and technology, representing 67.1% of the total; the annual share ranged from 61.5% to 76.0%. This demonstrates a stable professional and thematic orientation in student publication activity, although it should not be interpreted as a direct indicator of an individual student's level of professional competence.

*Conclusions***.** Research activities for students in engineering and pedagogical specialities should be organised as a continuous progression from a professionally significant problem to a research task, a well-substantiated technical and pedagogical solution, its testing, scholarly communication, and reflection. Within this framework, publication is not an end in itself but one outcome of meaningful research work and a means of entering professional and scholarly communities.

Keywords: methodology, organisation of student research, engineering and pedagogical speciality, higher education institution, motivation, professional orientation.

Introduction. The contemporary professional training of future engineering educators involves not only acquiring a body of technical, technological, and pedagogical knowledge but also developing the capacity to act in situations where no ready-made algorithm exists or where established procedures require professional reconsideration. Such specialists are distinguished by the integrated nature of their professional activity: they must understand the principles governing technical and technological processes while also being able to transform professional knowledge didactically, design learning activities, evaluate their outcomes, and substantiate pedagogical decisions. Within the professional competence of an engineering educator, the research component is naturally integrated with technological, design, communicative, and methodological competences, thereby giving research activities a directly professional focus (Kovalenko, Briukhanova, & Korolova, 2018). Research activities create a distinctive form of educational experience in which students move beyond reproducing acquired knowledge and learn to formulate questions, identify contradictions, work with evidence, select methods, obtain and interpret findings, argue for decisions, and assume responsibility for their justification. These actions develop critical thinking, independence, reflection, the capacity for self-directed learning, and professional mobility. Research work should therefore be viewed not as an optional supplement to core training but as one means of professionalising higher education students (Varava, 2018; Naboka, 2010; Kudla, 2023).

For students in engineering and pedagogical specialities, the professionalising potential of research is strengthened by the dual subject matter of their future work. Student inquiry may focus on a material, technology, equipment, a digital tool, a production process, or a design solution. Its professional value for an engineering educator increases, however, when the technical or technological outcome is also considered pedagogically: how it should be explained, demonstrated, modelled, and taught; how the relevant operations should be performed; and how the safe and effective acquisition of professional actions should be organised. Conversely, research on vocational teaching methods requires a precise understanding of the subject-specific and technological content through which those methods are implemented (Kovalenko, Briukhanova, & Korolova, 2018; Borysova, Usenko, & Ihnatenko, 2023). In this context, professional development should be understood as the gradual formation of a future specialist's professional orientation, competence, agency, and identity. Research becomes a means of this development when students do more than complete a formal assignment: they relate a problem to their future profession, make research decisions, recognise the practical significance of the outcome, gain experience in professional communication, and reflect on their place in the professional environment. Studies of professional identity among engineering students show that it develops as students relate their self-perceptions to professional expectations and practices, and that meaningful educational and professional experiences can significantly shape this process (Hren, 2010; McCall, McNair, & Simmons, 2021).

At the same time, student research in higher education institutions is often fragmented: research tasks within courses, term papers and qualification projects, research groups, conferences, and publications operate as separate forms with no consistently visible progression in professional complexity. Under such conditions, the external product—a conference paper, article, or competition entry—may become more prominent than the process of acquiring research and professional experience itself. By contrast, the literature emphasises the need for systematic organisation, continuity, integration of curricular and extracurricular components, and pedagogical support for student research (Ponomarova, 2010; Bieliaiev & Stetsenko, 2010; Korobchenko & Holovkova, 2019).

An additional empirical basis for examining this issue is provided by actual data from Dragomanov Ukrainian State University on the publication activity of students at its Faculty of Technology and Design from 2022 to 2026. The data comprise the total number of student publications and the number of works in engineering and technology. In this article, these figures are not treated as a direct measure of professional competence but as an institutional manifestation of the thematic orientation of student scholarly communication and a basis for comparing theoretical propositions with the Faculty's actual practice.

Literature review. Studies addressing the professional training of engineering educators regard the integrity of the professional competence system as a fundamental principle. Kovalenko, Briukhanova, and Korolova (2018) conceptualise it as a set of interrelated competences reflecting a specialist's professional orientation, knowledge, skills, professionally important qualities, and abilities. Including research competence within this system makes it possible to interpret student research as a way of mastering professional modes of thought and action rather than merely as preparation for an academic career.

The organisational structure of student research activities is examined in detail by Varava (2018) and Ponomarova (2010). They distinguish curricular research work, extracurricular forms, and research-related organisational activity while emphasising the need for these components to be interconnected. The curricular component includes problem-based inquiry tasks, laboratory and practical work, term papers and qualification research, and research elements within placements; the extracurricular component comprises research groups, problem groups, laboratories, and projects; and the scholarly communication component includes conferences, competitions, presentations, and publications. For professional development, what matters is not the mere variety of forms but the continuity of research actions and the gradual increase in student autonomy (Varava, 2018; Ponomarova, 2010).

Borysova, Usenko, and Ihnatenko (2023) emphasise the practice-oriented nature of student research. They demonstrate the importance of technical and design tasks, industrial placements, teaching and research laboratories, student design bureaux, competitions, exhibitions, and publications in engaging students in innovative solutions and professionally meaningful activities. Importantly, alongside activities prescribed by the educational programme, the authors identify voluntary, motivated student involvement as a factor that creates the conditions for progressing from the external completion of an assignment to internally motivated professional and cognitive engagement.

Kudla (2023) substantiates the direct relationship between research activities and professional development. She associates the effectiveness of this process with a coherent system of student research, interdisciplinary integration, the creation of a creative environment, psychological and pedagogical support, and dialogic interaction. From this perspective, research affects not only intellectual skills but also self-realisation, self-directed learning, reflection, and the design of future professional activity. Korobchenko and Holovkova (2019) take a similar view, treating the management of student research as a process focused on personal development and the realisation of creative potential.

The motivational and value dimension of professional development is particularly evident in Hren's (2010) study. She links orientation towards successful professional activity with professional and cognitive interest, a values-based attitude towards the profession, achievement motivation, independence, initiative, and reflection. Within the logic of contextual learning, research work and industrial placement form part of educational and professional activity that enables a transition from learning situations to modes of action approximating the real professional environment. For engineering and pedagogical specialities, this supports developing research topics around problems with clear technical, technological, and pedagogical content.

Yankin (2025) systematises the functional potential of research work by identifying educational, organisational and orientation, analytical and corrective, motivational, developmental, and formative functions. This approach is important to the present study because professional development cannot be reduced to a single indicator: it entails simultaneous changes in thinking, the organisation of activity, motivation, self-regulation, and professional behaviour. Naboka (2010) likewise substantiates the conception of research as a professionally oriented technology.

International studies further clarify the mechanisms through which undergraduate research experience exerts its effects. Hunter, Laursen, and Seymour (2007) associate research participation with cognitive, personal, and professional development; Thiry, Laursen, and Hunter (2011) emphasise the role of research practices in professional socialisation; and Linn et al. (2015) stress that positive outcomes depend on the quality of the research experience rather than participation alone. Faber et al. (2020) are particularly relevant to engineering education: students associated research with discovering new knowledge, disseminating findings, applying them for societal benefit, and researcher self-regulation. These characteristics are directly related to the professional agency of future engineering educators.

Earlier international research provides further detail on the professional-development potential of undergraduate research. Seymour, Hunter, Laursen, and DeAntoni (2004) identify personal and professional gains, the development of scientific ways of thinking and research skills, and the clarification of educational and career plans among its principal outcomes. Lopatto (2007) links student participation in research with more active learning and more deliberate career decision-making, while Russell, Hancock, and McCullough (2007) emphasise its importance for students' subsequent professional and academic development. Of particular relevance to this study are the findings of Zydney et al. (2002) in engineering education, which confirm the lasting influence of undergraduate research experience on graduates' educational and professional trajectories. More recent evidence from Cain et al. (2026) indicates that participation in authentic research practices can support the development of students' engineering identities and professional aspirations. Taken together, these findings justify viewing student research not merely as a way of acquiring discrete research skills but as an environment in which students gradually enter professional practice.

Nevertheless, the literature review shows that the mechanism by which research activities contribute to professionalisation within the dual professional domain of engineering and pedagogy remains insufficiently explained. Several questions require further specification: which forms of student research integrate technical and technological content with pedagogical design; how research experience supports professional orientation and agency; and what role publication and other forms of scholarly communication play in this process. These issues form the focus of the discussion that follows.

The aim of this article is to provide a theoretical rationale for research activities among students in engineering and pedagogical specialities as a means of their professional development; to specify their professionally oriented content, forms, and mechanisms of influence; to identify organisational and methodological guidelines for systematically integrating research work into professional training; and to analyse actual student publication data as one institutional manifestation of the professional orientation of student research.

Research methods. The study is theoretical and analytical and incorporates descriptive empirical material. To clarify the nature of research activities among students in engineering and pedagogical specialities, the study used analysis and synthesis of propositions from Ukrainian and international scholarship, comparison of approaches to organising student research, systematisation of its forms, functions, and professional-development outcomes, and synthesis of findings concerning professional competence, professional orientation, research experience, and professional identity (Kovalenko, Briukhanova, & Korolova, 2018; Kudla, 2023; Faber et al., 2020; McCall, McNair, & Simmons, 2021).

The empirical material consisted of aggregated actual data provided by Dragomanov Ukrainian State University on the publication activity of students at the Faculty of Technology and Design from 2022 to 2026. For each year, the total number of student publications and the number classified within the engineering and technology component were recorded. According to the source data, this component includes work on information and communication technologies, industrial engineering, materials science, transport and technical systems, manufacturing technologies, digital infrastructure, automation, design, and related fields. Absolute values and the proportional share of engineering and technology publications were compared descriptively. No causal conclusions regarding individual professional development were drawn from these aggregated data.

Results and discussion. Based on a synthesis of scholarly approaches, research activities among students in engineering and pedagogical specialities are defined here as purposeful curricular and extracurricular activities of progressively increasing complexity. Drawing on the methodology of scientific inquiry, students identify and investigate professionally significant technical, technological, and/or pedagogical problems; obtain and interpret findings; substantiate appropriate professional decisions; test those decisions; and present them to scholarly and professional communities. This definition combines the procedural, competence-based, and career-orientation dimensions of student research and is consistent with its integration into professional training (Ponomarova, 2010; Kovalenko, Briukhanova, & Korolova, 2018; Kudla, 2023).

A distinctive feature of these activities is their dual object of professional reflection. A future engineering educator engages simultaneously with the subject logic of engineering, technology, materials, production and digital processes, and with the logic of teaching people to perform the relevant professional actions. The most productive research therefore either extends a technical problem beyond a purely technical conclusion to include didactic interpretation or addresses a pedagogical problem while accounting for the precise technological characteristics of professional activity. This mutual translatability of engineering and pedagogical content turns research into an instrument for developing integrated professional competence (Kovalenko, Briukhanova, & Korolova, 2018).

The professional orientation of student research is determined primarily by the nature of the problem. A topic that exists merely as wording devised to satisfy an academic requirement has little effect on professional self-determination. By contrast, when a problem arises from a real or simulated professional context—such as the need to improve a technological process, investigate a material's properties, develop a digital or technical tool, compare ways of performing a professional operation, or test a teaching method or assessment instrument—the student immediately relates scientific inquiry to a future professional role. Contextual relevance, professional significance, and the ability to identify the intended user of the findings support a sustained professional and cognitive interest (Hren, 2010; Borysova, Usenko, & Ihnatenko, 2023).

Research activities undertaken by engineering education students should not be limited to preparing an article or qualification project. They comprise interconnected research actions: searching for and critically selecting scholarly and technical information; analysing regulatory, methodological, and technological sources; formulating a problem and research question; substantiating methods; conducting observation, measurement, experimentation, design, or testing; analysing and visualising findings; comparing the data obtained with existing approaches; formulating technical and pedagogical conclusions; preparing recommendations; and presenting and discussing the findings. Each action can be incorporated into various curricular and extracurricular activities (Varava, 2018; Ponomarova, 2010; Yankin, 2025).

Within the curriculum, research actions should be distributed according to a principle of progressively increasing complexity. In the early years of study, activities involving scholarly information predominate: searching, evaluating source reliability, comparing approaches, and formulating concise evidence-based conclusions. At intermediate stages, these activities are supplemented by small-scale studies, problem-based laboratory and practical work, technical and technological experiments, and analyses of specific pedagogical and production situations. In the later years, research should become holistic through term papers and qualification projects, teaching and industrial placements, team projects, conference participation, and publication activity. Such continuity enables a transition from externally directed actions to autonomous research behaviour (Varava, 2018; Ponomarova, 2010; Kudla, 2023).

Teaching and industrial placements occupy a special place because they bring research into contact with professional reality. During an industrial placement, students can analyse process conditions, workplace organisation, equipment use, and the effectiveness of digital or automated solutions. During a teaching placement, they can observe how professional actions are acquired, diagnose common difficulties, and test explanations, instruction, demonstrations, digital learning resources, or assessment methods. Combining these two fields of inquiry creates the conditions for developing the capacity not merely to understand a technology but to teach it professionally and improve the process through which it is mastered (Hren, 2010; Borysova, Usenko, & Ihnatenko, 2023).

Extracurricular student research expands the scope for autonomy. Work in research groups, problem groups, laboratories, and project teams, as well as participation in competitions and conferences, enables students to engage with a topic over a longer period, move beyond a prescribed task, interact with other students and lecturers, and compare their findings with those of others. The pedagogical effectiveness of these formats depends, however, on the extent to which they address professionally significant issues and complement rather than duplicate classroom learning (Bieliaiev & Stetsenko, 2010; Korobchenko & Holovkova, 2019).

A balance between research supervision and student autonomy is an important organisational principle. Supervisors should help students refine a problem, determine a realistic scope for the study, learn to work with sources and data in a methodologically sound manner, and avoid evident errors. They should not, however, make research decisions on the student's behalf. The lived experience of choosing, making mistakes, revising, and re-arguing a position develops responsibility for the outcome and a reflective stance. Excessively directive supervision reduces research to following instructions, whereas insufficient support increases the risk of merely simulating research work (Kudla, 2023; Faber et al., 2020).

The influence of professionally oriented research activities should not be explained as a direct relationship between "participation in research" and "acquired competence," but as a set of mechanisms realised when the research experience meets certain standards of quality. The first is the cognitive-methodological mechanism: students acquire a mode of thinking that requires them to distinguish fact from assumption, recognise the limits of evidence, verify sources, select an appropriate method, and connect conclusions to the data obtained. This is especially important for engineering educators because their professional decisions concern both technical safety and effectiveness and pedagogical appropriateness (Naboka, 2010; Yankin, 2025).

The second, professional-practical mechanism involves transferring theoretical knowledge into professional action. A research task requires students to apply material from different disciplines not in isolation but to solve a specific problem, compare alternative solutions, assess constraints, and anticipate consequences. At this level, the engineering and pedagogical components become integrated: a technical or technological solution is assessed for its suitability in teaching, while a pedagogical solution is evaluated for subject-matter accuracy and technological feasibility (Kovalenko, Briukhanova, & Korolova, 2018; Borysova, Usenko, & Ihnatenko, 2023).

The third is the motivational-value mechanism. Research supports professional motivation when students understand the significance of a problem, have some freedom of choice, can see a tangible outcome, and recognise its potential application. Participating in work whose findings may be used in a technological process, teaching laboratory, methodological resource, or subsequent project strengthens students' sense of professional belonging and self-efficacy. External incentives—grades, certificates, and publications—may sustain activity, but a stable professional orientation develops primarily through intrinsic value and professional and cognitive interest (Hren, 2010; Kudla, 2023; Lopatto, 2007).

The fourth mechanism is reflective. Scientific inquiry continually requires students to assess their own actions: why a particular method was selected; which data are sufficient; what limitations affect the findings; why the initial assumption was not confirmed; and what should be changed in subsequent work. This reflection gradually transfers to professional activity, preparing students not to reproduce a technological or pedagogical procedure mechanically but to analyse its effectiveness and adjust their own actions (Kudla, 2023; Korobchenko & Holovkova, 2019).

The fifth, communicative-identification mechanism operates through the presentation and validation of findings. Delivering a paper, participating in a discussion, defending a project, attending a conference, or preparing an article requires students to structure professional knowledge, respond to critical questions with reasoned arguments, accept feedback, observe academic integrity, and present themselves as authors of a professionally significant outcome. Participation in the practices of a professional community facilitates the transition from "a student completing an academic task" to "a future specialist capable of creating, substantiating, and communicating solutions" (Hunter, Laursen, & Seymour, 2007; Faber et al., 2020; McCall, McNair, & Simmons, 2021; Zydney et al., 2002; Cain et al., 2026).

Together, these mechanisms develop professional agency. Students gain experience in setting goals, planning, selecting tools, assuming responsibility for decisions, interacting with a supervisor and peers, and engaging in critical self-evaluation. The professional effect of student research therefore depends on the completeness of the research cycle and the extent to which students themselves make substantive decisions. International reviews likewise caution against automatically attributing positive outcomes to any form of research participation: the quality of mentoring, authenticity of tasks, duration of engagement, and opportunity to reflect on the experience all matter (Linn et al., 2015; Thiry, Laursen, & Hunter, 2011; Seymour et al., 2004; Russell, Hancock, & McCullough, 2007).

A systematic approach to research activities requires their various forms to be connected not only chronologically but also substantively. An educational research task in a professional discipline may provide the basis for a small-scale study; its findings may inform a term paper or project assignment; a professional placement may provide a setting in which to test or refine the solution; and a conference presentation or publication may serve to validate the work and bring a particular stage to a reflective conclusion. Such connections support the cumulative nature of research experience and enable students to see their professional trajectory as it develops (Varava, 2018; Ponomarova, 2010; Kudla, 2023).

Table 1

Forms of Research Activity among Students in Engineering and Pedagogical Specialities and Their Professional-Development Potential

Form and content of activity	Typical research actions	Professional-development outcomes
Curricular research	source analysis; problem-based laboratory and practical work; small-scale studies; term-paper and qualification research	scientific thinking; methodological literacy; ability to work with evidence; integration of specialist knowledge
Technical, technological, and design activity	experimentation with materials and technologies; modelling; design; testing of technical and digital solutions	design and technological competence; ability to evaluate alternatives and substantiate engineering decisions
Pedagogical research	observation; diagnosis of difficulties; testing of a method, demonstration, instruction, digital tool, or assessment technique	methodological competence; ability to analyse the educational process and adjust pedagogical decisions
Practice-integrated research	research tasks during industrial and teaching placements; analysis of authentic professional situations	transfer of knowledge into professional action; responsibility; professional reflection; understanding of the work context
Collaborative and scholarly communication	research groups, laboratories, and project teams; conferences; competitions; defences; conference papers and articles	teamwork; argumentation; academic integrity; professional self-presentation and entry into the community

Source: compiled by the author based on Varava (2018), Ponomarova (2010), Kovalenko, Briukhanova, and Korolova (2018), Borysova et al. (2023), and Kudla (2023)

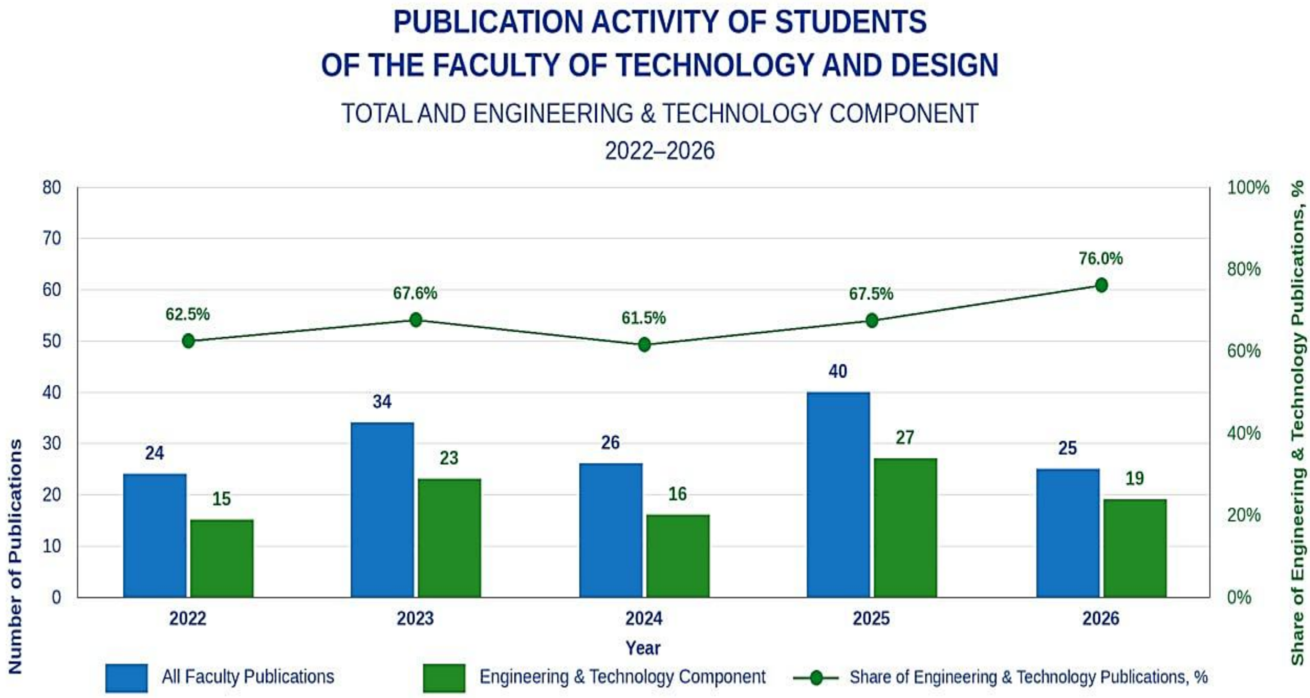
Table 1 shows that the same research activity can simultaneously contribute to several groups of professional outcomes. For example, a technical and technological experiment develops not only engineering thinking but also the ability to document and explain a procedure, justify the choice of criteria, and present a conclusion. A small-scale pedagogical study, in turn, requires accurate subject content and an understanding of the relevant technological operation. This cross-cutting contribution to multiple outcomes explains why research activities effectively integrate the two components of engineering and pedagogical training (Kovalenko, Briukhanova, & Korolova, 2018).

From a methodological perspective, research activities must not be reduced to the formal preparation of a text. A publication should conclude a particular stage of scientific inquiry rather than serve as its initial objective. It should be preceded by the formulation of a professionally significant problem, engagement with relevant sources, the collection or analysis of data, the testing of a solution, critical discussion, and revision. Within this sequence, an article or conference paper becomes a means of organising professional knowledge, entering scholarly communication, and consolidating the author's professional position (Varava, 2018; Faber et al., 2020). Motivational design also requires attention. Students should see not only the wording of a topic but also its professional significance: precisely what the study will help them understand, improve, design, test, or teach others to perform. Productive arrangements include a range of thematic fields, opportunities to choose a specific object or aspect, work with real technological and pedagogical situations, and participation in long-term research-group and project topics. These arrangements create the conditions for moving from external motivation to a sustained professional and cognitive interest (Hren, 2010; Kudla, 2023).

For interdisciplinary topics, consultation and collaboration between lecturers specialising in technical and technological fields and those specialising in pedagogy can be productive. This does not mean formally increasing the number of supervisors, but rather ensuring the coherence of the professional concept so that the “technical” and "pedagogical" parts of the study do not exist in parallel. This approach is especially appropriate when students investigate a technical or digital tool while developing a method for its use in vocational education, or when a pedagogical solution requires experimental verification of technological parameters (Borysova, Usenko, & Ihnatenko, 2023; Kovalenko, Briukhanova, & Korolova, 2018).

Professional reflection should conclude every significant research cycle. Following testing or publication, students should consider not only "what outcome was obtained?" but also "what have I learned as a future specialist?", "which professional decisions can I now substantiate?", "what errors have I identified in my way of working?", and "which question requires further investigation?". Such reflection transforms a result from an isolated academic exercise into personal professional experience and supports the development of professional identity (Kudla, 2023; McCall, McNair, & Simmons, 2021).

Publication activity is only one visible outcome of the broader system of student research. It does not encompass every research task, experiment, placement, project, or research-group activity, nor does it permit a direct measurement of professional competence. Nevertheless, the thematic structure of publications indicates how prominently professionally significant issues feature in student scholarly communication. Actual data from the Faculty of Technology and Design for 2022–2026 are presented in Figure 1.



Indicator	2022	2023	2024	2025	2026
All Faculty Publications, units	24	34	26	40	25
Engineering & Technology Component, units	15	23	16	27	19
Share of Engineering & Technology Publications, %	62.5%	67.6%	61.5%	67.5%	76.0%

Note. The engineering & technology component includes publications related to the following areas: information and communication technologies, industrial engineering, materials science, transport systems, manufacturing technologies, digital infrastructure, automation, design, etc.

Figure 1. Publication Activity of Students at the Faculty of Technology and Design: Total Output and the Engineering and Technology Component, 2022–2026

Source: compiled from data provided by Dragomanov Ukrainian State University

Analysis of Figure 1 shows that the engineering and technology component consistently accounted for the majority of student publications between 2022 and 2026. In 2022, 15 of 24 publications were in the relevant fields, representing 62.5%. In 2023, the total number of publications increased to 34, of which 23 addressed engineering and technology, representing 67.6%. In 2024, 16 of 26 publications had an engineering and technology focus, corresponding to 61.5%, the lowest value in the period analysed. The highest absolute publication output was recorded in 2025: 40 works, of which 27, or 67.5%, were in engineering and technology. In 2026, there were 25 publications in total, of which 19 addressed engineering and technology; their share reached a period high of 76.0%. Overall, 100 of 149 student publications produced between 2022 and 2026, or 67.1%, were classified within the engineering and technology component.

For the subject of this study, the stability of the professional and thematic structure of publications is more important than fluctuations in their absolute number. Even in the year with the lowest share of engineering and technology works, it did not fall below 61.5%; in 2026, it reached 76.0%. This confirms the stable presence of professionally significant issues in student scholarly communication.

From a professional-pedagogical perspective, this result is important because publication topics reflect student engagement in researching issues connected with their future professional activity: technologies, engineering and digital solutions, materials, automation, and design. Working with professionally relevant subject matter creates the conditions for deepening specialist knowledge, mastering methods of analysis and argumentation, gaining design experience, and developing the capacity to substantiate decisions. This is consistent with scholarship describing the professionally oriented nature of student research and its relationship to the development of professional competence (Naboka, 2010; Borysova, Usenko, & Ihnatenko, 2023; Faber et al., 2020).

At the same time, the data in Figure 1 do not justify equating the number or share of publications with an individual student's level of professional development. Professional development is a personal process and requires information on motives for participation, the nature of student autonomy, the substance of the research actions performed, the quality of mentoring, placement outcomes, reflection, and subsequent professional trajectories. The figure therefore serves in this article as empirical confirmation of the stable professional and thematic orientation of student research, while the mechanism of professional development itself is substantiated through the content and organisation of research activities (Linn et al., 2015; Thiry, Laursen, & Hunter, 2011).

Publication activity therefore acquires professional-development value only as the final stage of a complete research cycle. When a publication results from independently identifying a problem, working with scholarly and technical sources, obtaining or interpreting data, developing and testing a technical and pedagogical solution, interacting with a research supervisor, and undertaking critical revision, publication contributes to professional self-presentation, the formation of a research identity, and entry into a professional community. When a publication is detached from such a cycle, its pedagogical potential is substantially diminished (Hunter, Laursen, & Seymour, 2007; Faber et al., 2020).

Conclusions. Research activities among students in engineering and pedagogical specialities are an integrated component of professional training that combines the methodology of scientific inquiry, technical and technological content, pedagogical design, practical testing, scholarly communication, and reflection. Their professional potential is determined not by the number of completed works as such, but by the extent to which the research process is connected to real or simulated problems arising in future professional activity. Engineering and pedagogical specialities are distinguished by the dual professional orientation of research. Future specialists must not only investigate technical, technological, materials-related, digital, or design objects but also be able to interpret the knowledge gained pedagogically; conversely, research into a pedagogical problem must be grounded in accurate subject-specific and technological content. This integration creates a foundation for the development of the engineering educator's holistic professional competence.

The effect on professional development is realised through cognitive-methodological, professional-practical, motivational-value, reflective, and communicative-identification mechanisms. These mechanisms develop the capacity to recognise a professional problem as a research problem, work with evidence, select and substantiate solutions, transfer knowledge into professional action, critically evaluate one's own results, communicate them to a professional community, and perceive oneself as an agent of one's future profession. Actual publication data from the Faculty of Technology and Design for 2022–2026 show the sustained predominance of engineering and technology topics: 100 of 149 publications, or 67.1%, belonged to this component, with annual shares ranging from 61.5% to 76.0%. This supports characterising student scholarly communication as strongly professionally oriented in thematic terms, although the figures do not directly measure individual professional competence. The organisational and methodological support of student research should be based on continuity and progressively more complex research actions; the integration of research tasks into professional disciplines and placements; a focus on professionally relevant problems; variation and freedom of choice; mentoring support combined with gradually increasing autonomy; a combination of individual and collaborative work; and mandatory testing and professional reflection. Within this system, publication is not an end in itself but one outcome of meaningful research activity and a means of professional socialisation.

Further research should combine institutional indicators of student research activity with individual data on motivation, research skills, professional identity, levels of autonomy, the outcomes of teaching and industrial placements, and subsequent professional trajectories. This would make it possible to determine more precisely which forms and methods of organising research activities have the greatest influence on the professional development of students in engineering and pedagogical specialities.

Conflict of Interest

The author certifies that no conflict of interest (financial, professional, or personal) exists that could have influenced the objectivity of the research results or conclusions. The integrity of the double-blind peer review process was ensured through a mandatory declaration of the absence of conflict of interest submitted via the journal's editorial system. This protocol guaranteed complete author anonymity and the independence of the expert evaluation throughout the entire editorial cycle.

Declaration on the Use of Generative Artificial Intelligence.

During the preparation of this manuscript, the authors used Microsoft Copilot chat for searching and verifying bibliographic data, organizing materials, calculating derived indicators, preparing figures, and language editing and formatting of the text. The conceptual model, empirical data, scientific conclusions, and interpretation of the results are the authors' own. Following the use of the tool, the entire manuscript was reviewed and edited by the authors, who take full responsibility for its content and scientific accuracy. Artificial intelligence is not a co-author of this work.

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НАУКОВО-ДОСЛІДНА ДІЯЛЬНІСТЬ У ПРОФЕСІЙНІЙ ПІДГОТОВЦІ СТУДЕНТІВ ІНЖЕНЕРНО-ПЕДАГОГІЧНИХ СПЕЦІАЛЬНОСТЕЙ

Катерина Лукашенко

науковий співробітник відділу педагогічного джерелознавства, Державна науково-педагогічна бібліотека імені В. О. Сухомлинського, https://orcid.org/0000-0002-4457-4423, e-mail: berezanskaya1994@gmail.com

Реферат:

Актуальність. Професійне становлення студентів інженерно-педагогічних спеціальностей відбувається в умовах інтеграції техніко-технологічної та педагогічної підготовки, що потребує здатності не лише засвоювати готові знання, а й самостійно виявляти професійні проблеми, обирати способи їх дослідження, обґрунтовувати рішення та оцінювати їх результативність. Науково-дослідна діяльність у цьому контексті набуває значення засобу професіоналізації, оскільки поєднує пізнавальну активність, практичне розв'язання фахових завдань, мотивацію до саморозвитку, наукову комунікацію та рефлексію.

*Мета***.** Теоретично обґрунтувати роль науково-дослідної діяльності у професійній підготовці студентів інженерно-педагогічних спеціальностей.

*Методи***.** Теоретико-аналітичне дослідження здійснено на основі компаративного й системно-функційного аналізу наукових праць, систематизації та узагальнення концептуальних засад розвитку професійної компетентності, спрямованості й ідентичності студентів інженерно-педагогічних спеціальностей. Застосовано метод описового зіставлення агрегованих емпіричних даних Українського державного університету імені Михайла Драгоманова щодо публікаційної активності студентів Факультету технологій та дизайну за 2022–2026 рр. Проведено аналіз абсолютних значень і динаміки структурної частки праць інженерно-технологічного профілю (роботи з ІКТ, промислової інженерії, матеріалознавства, автоматизації, проєктування) без генерації індивідуальних причинно-наслідкових висновків.

*Результати***.** Обґрунтовано, що потенціал науково-дослідної діяльності студентів для професійного становлення реалізується через взаємодію когнітивно-методологічного, професійно-практичного, мотиваційно-ціннісного та рефлексивно-комунікативного механізмів. Визначено доцільність поєднання навчально-дослідних завдань у фахових дисциплінах, дослідницьких компонентів практик і проєктів, роботи наукових гуртків і лабораторій, участі у конференціях та підготовки публікацій. Встановлено, що у 2022–2026 рр. із 149 студентських публікацій 100 належали до інженерно-технологічної складової, тобто 67,1 % загального масиву; у кожному з років її частка становила від 61,5 % до 76,0 %. Це засвідчує стійку професійну тематичну орієнтацію студентської публікаційної активності, але не розглядається як прямий показник індивідуального рівня професійної компетентності.

*Висновки***.** Науково-дослідна діяльність студентів інженерно-педагогічних спеціальностей доцільно організовувати як безперервний процес переходу від професійно значущої проблеми до дослідницького завдання, обґрунтованого техніко-педагогічного рішення, його апробації, наукової комунікації та рефлексії. Публікація в такій логіці є не самоціллю, а одним із результатів змістовної дослідницької роботи й засобом входження студента у професійну та наукову спільноту.

Ключові слова: *методика, організація наукової роботи студентів, інженерно-педагогічна спеціальність, ЗВО, мотивація, професійна орієнтація*.

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