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Methodological Approach to Build a Mentorship System in Higher Technical Education: An Enhanced Model

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P A P E R   I N F O

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A B S T R A C T

Mentorship, as a form of pedagogical activity, has recently gained particular importance within the system of higher engineering education. The transformation of the educational environment and the increasing demand for professionally and socially competent engineers have led to the need for the new approaches to student guidance and development. Educational and formative work carried out with students represents an integral component of the learning process and requires modernization in light of the ongoing reform of higher education. This paper presents an analysis of leading national and international practices in the field of mentorship and describes a comprehensive mentorship model developed and implemented at the Empress Catherine II Saint Petersburg Mining University. The model defines the goals, principles, and structure of mentorship within the university context. Two main categories of pedagogical mentors are identified -academic group curators and disciplinary mentors -for whom specific performance evaluation criteria and efficiency indicators are proposed. The implementation experience demonstrates the model's potential for enhancing student engagement, motivation, and professional development. The findings of this study demonstrate that a systematic, continuous, and values-oriented mentorship model facilitates not only academic adaptation but also the development of professional motivation and civic responsibility among the prospective engineers.

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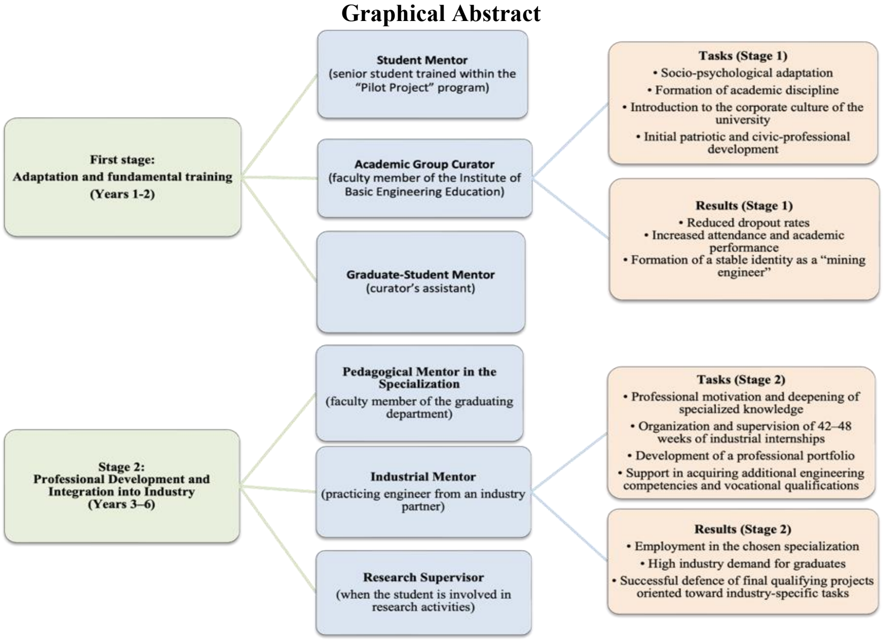
Graphical Abstract



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1. INTRODUCTION

Mentorship (mentoring) represents a purposeful process of providing assistance, support, and guidance to an individual in their personal development, life choices, growth, and self-improvement. This interaction is built upon the transfer of experience, knowledge, and principles from a more mature and competent mentor to a less experienced person. The phenomenon of mentorship is universal and observed in most world cultures, reflecting the enduring human need for intergenerational transmission of values and skills.

Examples of mentorship in the scientific community are well known. For instance, twelve of Ernest Rutherford's students became Nobel laureates in physics and chemistry.

In Russian pedagogy, the issue of mentorship has always been of particular interest. The founder of national pedagogy, Ushinsky (1823–1871), pointed to the direct dependence of an individual's professional adaptation on the level of pedagogical skill and knowledge of their mentor. The works of scholars representing the St. Petersburg School of Mathematics — Bunyakovsky, Chebyshev, Markov, Lyapunov, Khinchin, and others — are well-known examples of the "teacher–student" relationship in higher mathematics.

In the 1930s, the Italian antifascist and aircraft designer Roberto Bartini stood at the origins of Soviet jet aviation. He was the author of fundamental works in physics and aerodynamics, under whose supervision Sergey Korolev, one of the principal creators of rocket and space technology in the USSR, began his scientific career.

In recent decades, beginning in the 1980s, mentorship has evolved into a systemic form. Today, it is implemented through specially designed programs in educational institutions, professional organizations, and social initiatives. This approach enables structuring the process, adapting it to specific objectives and audiences, and evaluating the results achieved.

The importance of an effective mentorship system for higher engineering education can hardly be overstated under current geopolitical conditions. Achieving national sovereignty for the Russian Federation is impossible without highly qualified engineering personnel motivated to work in the core sectors of domestic industry. The training and moral development of young engineers are inseparable; neglecting either component of the educational process inevitably leads to failures in the preparation of engineering professionals.

For this reason, the Empress Catherine II Saint Petersburg Mining University (hereinafter "the Mining University") is actively improving its system of engineering education as part of a state experimental program ("Pilot Project") (1). Since 2023, 2150 students have been enrolled in the new educational program "Higher Engineering Education," and in 2024, an additional 2180 students were admitted across 60 engineering specializations. The results of this experiment are expected to be disseminated to all state universities of the Russian Federation beginning in 2027 (2).

The objectives of this article are to review mentorship practices in higher education institutions and to substantiate a methodological approach to constructing a mentorship model as an integral component of modern engineering education at the Mining University. The study does not aim to rigidly formalize all procedures and elements related to the educational and developmental work with students (which is inherently subjective by nature). Nevertheless, in constructing the mentorship model, the authors widely employ the concepts and principles of systems management theory, commonly used across multiple fields of knowledge (3-6).

2. REVIEW OF CONTEMPORARY MENTORSHIP PRACTICES

Despite extensive research, mentorship remains a complex phenomenon to conceptualize. Scholars generally identify several key areas of focus:

- Effectiveness of mentorship — analysis of factors determining the success of mentorship programs (e.g., conditions of interaction, personal qualities of the mentor, criteria for evaluating outcomes).
- Training of mentors — development of methods for forming mentors' professional and personal competencies.
- Diversity of forms — study of various types of mentorship (formal, informal, digital, group-based, etc.) and their adaptation to different contexts.

Thus, modern pedagogy aims not only to define the essence of mentorship but also to transform it into a flexible tool for achieving educational, social, and career objectives (7-10).

Mentorship in higher engineering education in Russia has deep historical roots. At the Saint Petersburg Mining University, founded in 1773, mentorship represents a synthesis of historical tradition and modern educational practice. Research on the university's history and its unique educational system (11-13) emphasizes the role of distinguished educators — scientists and engineers — who laid the foundation of Russia's system of engineering education and cultivated the national engineering and technical intelligentsia responsible for managing the country's mineral resources (14).

The best traditions of mentorship have been upheld by generations of Mining University graduates who established dynasties of mining engineers (15-17). As early as the first third of the nineteenth century, the Mining Cadet Corps successfully implemented a pioneering practice of mutual mentorship between senior and junior cadets.

This innovative approach, later conceptualized as peer mentoring, has only been widely studied in the 21st century and is now actively discussed in the pedagogical community both in Russia (18) and abroad. Studies carried out in literature (19-22) that when senior students and alumni help new students adapt by serving as mentors, this practice not only reduces academic stress and improves academic performance but also fosters the development of leadership qualities.

The Mining University possesses a unique cultural and educational environment, a significant component of which is the Mining Museum — an educational space where integrated forms of mentorship are implemented during the study of mineralogy, geology, and the history of technology (23). The museum introduces students to the university's traditions and facilitates the transfer of practical experience from teachers to students, reflecting the concept of situational learning (24).

The ethics of mentorship is considered a key component of effective mentoring, becoming increasingly important under conditions of growing competition and multitasking. Vasilieva et al. (25) highlighted principles such as respect for the learner's individuality, confidentiality, and maintaining a balance between support and independence (26).

Studies conducted by Allen (27), James et al. (28), Goldner and Mayseless (29) have focused on the personal qualities of mentors that enhance effective and motivated guidance of student youth.

The professionalization of mentorship requires systematic preparation and continuous training of teachers. Stoeger et al. (30) and Hašková et al. (31) emphasized the importance of mastering best practices, regularly assessing mentorship programs, and providing institutional support for mentors. However, there remains a shortage of qualified mentors undergoing regular professional development (32).

Modern engineering universities are developing programs that combine academic education with project-based learning. Interdisciplinary projects for first-year students demand that mentors possess team management skills and the ability to integrate knowledge from multiple disciplines.

As noted by Koppikar et al. (33), engineering faculty must possess not only subject-specific expertise but also soft skills such as conflict management, time management, and emotional intelligence — skills increasingly essential amid the rising complexity of technical challenges requiring cross-disciplinary integration (34).

A systemic integration of mentorship into the educational process is now evident: mentorship is institutionalized as a component of academic programs, embedded into course modules, research projects (35), and practical training. The effectiveness of mentorship is formalized through evaluation systems (credit-based grading, certification). Parallel programs for mentor training are also being implemented to develop pedagogical and mentoring competencies.

Contemporary engineering education requires flexible approaches to mentorship. Gindes et al. (36) proposed a mentorship concept incorporating:

- Personality-oriented support (individual counseling, goal setting assistance),
- Professional mentorship (engagement in research and internships), and
- Digital integration (online platforms for feedback and monitoring).

Recent studies confirm that mentorship is a powerful tool for supporting both students and faculty (37-40), though its effectiveness depends on a systemic approach that accounts for context, objectives, and mentor preparedness (41).

A comparative analysis carried out by Tikhonova et al. (42) shows that in the EU and the USA, mentorship models emphasize flexibility:

- Reverse mentoring (exchange of expertise between experienced educators and "digital natives"),
- Online mentorship (use of digital platforms for personalized learning),
- Corporate mentorship programs (university–industry collaboration).

However, direct replication of Western models is not always effective in the Russian context. As Likholetov (43) noted, successful adaptation required consideration of national characteristics, particularly the emphasis on the fundamental nature of engineering education.

The digitalization of education has also transformed traditional mentorship methods. Asadullin et al. (44) highlighted the need to assess teachers' digital competencies: only 34% of Russian university faculty confidently use online tools for mentorship. The introduction of interactive platforms, as demonstrated by Dorofeev and Korchagina (45), automates routine tasks (e.g., assignment checks, progress analysis), enables virtual workshops with industrial experts, and creates digital student portfolios for tracking professional growth.

Implementation of online platforms (LMS, specialized services) expands opportunities for remote interaction and access to learning resources. Technologies such as virtual reality, simulators, and analytics systems optimize the mentorship process while enhancing students' digital literacy — a key competence in the digital economy.

At the same time, maintaining a balance between digital and in-person mentorship remains essential: students must not experience a deficit of personal interaction with their mentors.

The practice-oriented paradigm of mentorship development in engineering education envisions the expansion of professional mentorship, wherein faculty mentors serve as links between universities and industry. They help attract professionals from the real sector into mentorship programs, ensuring the transfer of relevant industrial expertise. Students, in turn, engage in solving applied cases, participating in project activities, and building professional portfolios, thereby developing both hard and soft skills demanded in the labor market.

Vedhathiri (46) emphasizes the crucial role of industrial internships, where mentors from production facilities assist students in applying theoretical knowledge to practical contexts.

Based on the studies conducted by international researchers (42-45), a comparative analysis was performed with foreign educational practices, in particular with the Canadian CO-OP programs and the German dual education system (Duales Studium), which are currently regarded as among the most effective models for engineering workforce training worldwide (see Table 1) (48-51). The analysis demonstrates that the Russian model implemented at the Mining University integrates the strengths of international approaches—such as the systematic structure of practical training and the active involvement of industry—while complementing them with a unique educational and value-oriented component aimed at shaping engineers with a strong sense of national responsibility. This feature is particularly significant in the context of technological sovereignty and import substitution.

In summary, mentorship in higher education is evolving from spontaneous practices to systemic solutions that combine individualization with practical orientation. Its role as a tool for preparing competitive specialists is confirmed by both theoretical research and empirical evidence.

Based on the analysis of traditional and modern best practices, we now proceed to the formulation and description of the main elements of the mentorship model implemented at the Mining University.

3. INITIAL DATA AND PROBLEM DEFINITION

An analysis of the "psychological profiles" of first-year students admitted to the Mining University reveals several key factors influencing the effectiveness of educational work:

1. Up to 80% of first-year students come to St. Petersburg from other regions and demonstrate relatively low levels of foundational knowledge in mathematics, physics, and chemistry.
2. For the vast majority of students, the orientation toward personal success and well-being is dominant. According to a VCIOM survey (2002), the top three life priorities of Russian youth are: a high standard of living (58%), a peaceful life focused on family and work (54%), and contributing to society and public life (26%) (47). Thus, state-centered values do not occupy leading positions among youth priorities.

TABLE 1. Comparative Analysis of International Mentorship-Based Educational Model

Criteria	Russia (Saint Petersburg Mining University, Pilot Project)	Canada (CO-OP Programs)	Germany (Duales Studium)
Duration of Training	6 years (specialist degree program)	4–5 years (bachelor's degree + COOP year)	3–4 years (bachelor's degree) + possible master's program
Integration of Practical Training	42–48 weeks of distributed practical training over 6 years	12-month continuous industrial internship after the third year of study	Alternation of theoretical modules (university) and practical modules (enterprise) every 3–6 months
Role of Mentorship	Two-level system: academic curator + specialty mentor + industry mentor	University mentor + company mentor during the COOP period	Industry mentor + academic advisor
Development of Soft Skills	Through educational activities, student self-governance, and civic–patriotic initiatives	Through real work tasks and corporate culture	Through strict industrial discipline and project-based activities
Additional Qualifications	At least 8 engineering competencies + 2 vocational qualifications	Professional certificates may be obtained (optional)	Qualification according to the IHK standard (Chamber of Industry and Commerce)
Value-Based and Civic-Patriotic Component	Explicit component: linking the engineer's well-being to the development of Russia	Not included	Emphasis on professional ethics and collective responsibility
Expected Outcomes	Graduate profile: a practice-oriented engineer ready to work at strategic enterprises of the Russian Federation	Graduate profile: a competitive specialist with international experience	Graduate profile: a highly qualified technician/engineer with deep industrial integration

3. The highly saturated information environment, particularly social media, influences students' value systems — bloggers with large followings often appear as greater authorities than parents or university professors.
4. After thirty years of liberal ideological dominance, the historical continuity between generations has been significantly disrupted. Few participants of the Great Patriotic War remain, and for many students its events are perceived as distant history rather than part of a living national narrative. Consequently, patriotic events lacking relevance to the modern context have little educational effect and are often perceived as obligatory or entertainment-based activities (e.g., exhibitions of military vehicles, trying on uniforms, or decorating cars and goods with St. George ribbons).

According to authors, successful student upbringing requires the formulation of three fundamental components:

- The goal of higher education in the university;
- The central idea of educational work; and
- The system designed to achieve this goal.

Based on labor market analysis and the experience of the Mining University and other Russian institutions, these components can be articulated as follows:

- Goal of educational activity: to train highly qualified engineers motivated to work in domestic enterprises.
- Core idea of educational work: the personal well-being of each student is inseparable from the well-being of Russia.
- Foundation of educational work: a multi-level mentorship system oriented toward achieving the objectives of educational activity.

Analysis of the Strengths and Weaknesses of the Traditional Model of Engineering Education in the Russian Federation:

To substantiate the need for introducing a new mentorship model, it is necessary to critically assess the current (traditional) system of engineering education in Russian universities.

Weaknesses of the traditional model include:

• Disconnection between the educational and developmental processes: academic advisors typically do not participate in teaching and mainly perform administrative functions, which renders the developmental component fragmented and largely formal.

• Low academic readiness of incoming students: a significant proportion of first-year students enter university with an insufficient level of knowledge in fundamental subjects, which complicates the assimilation of engineering courses from the very beginning of their studies.

• Lack of continuous guidance: the change of academic advisors when students transition to senior years disrupts the continuity of the developmental and mentorship trajectory.

• Weak connection with industry: industrial internships are often formal in nature and are conducted without the involvement of experienced engineers or mentors from enterprises.

• Implicit value dimension: patriotic education is delivered through isolated events and is not systematically integrated with students' professional motivation or personal goals.

Strengths preserved within the new model include:

• A strong foundation in the natural, exact, and humanities sciences, which constitutes a historic advantage of the Russian engineering school.

• Rich university traditions, particularly in technical institutions with long-standing histories (such as the Mining University, founded in 1773), including extensive museum, archival, and scientific resources.

• High engagement of the academic staff in both research and educational activities.

• The presence of institutional commitment to modernization, exemplified by the launch of the national experimental initiative ("Pilot Project") on the new educational program *Higher Engineering Education* (Presidential Decree of the Russian Federation No. 343, dated 12 May 2023).

Thus, the new mentorship model implemented at the Mining University does not replace the traditional strengths; rather, it transforms the existing weaknesses into points of growth through:

• Integrating education and personal development via the role of a faculty-based academic curator;

• Ensuring continuous student guidance over the full six-year program;

• Involving industry mentors and developing a professional portfolio;

• Aligning students' personal motivation with national development objectives.

This transformation responds to contemporary challenges and supports the achievement of a strategic objective—training engineers capable of ensuring the technological sovereignty of the Russian Federation.

In conclusion of this session, the following statements are highlighted:,

Limitations of the current system:

- a disconnect between educational (value-based) and academic activities;
- the formalized nature of curatorial work;
- the absence of systematic support at senior stages of study;
- low student engagement with patriotic and professional values;

- weak linkage with industry.

Advantages of the proposed model:

- continuous mentorship throughout the six-year educational trajectory;
- personalized academic and developmental support;
- integration of education, instruction, and practical training.

4. MENTORSHIP MODEL AND PERFORMANCE INDICATORS

Figure 1 shows the mentorship model developed and implemented at the Mining University; which is closely integrated with the educational process carried out under the “Pilot Project.” Based on an analysis of global (external) and local factors affecting the effectiveness of higher education, the project introduces a set of measures aimed at endowing engineering education with new qualities, the key elements of which include:

1. Fundamental and in-depth study of core general and technical disciplines during the first and second years, taught by the departments of the Institute of Basic Engineering Education.
2. Specialized disciplines delivered by graduating departments, reinforced through a substantial volume of practical and industrial experience — 42–48 weeks over the six-year training period.
3. During the six years of study, students must acquire additional engineering competencies (at least 8) and practical worker-level specializations (at least 2).

The mentorship model of the Mining University represents a multi-level system of student support implemented throughout all stages of study and involving three key categories of mentors: a peer mentor selected from senior students, a pedagogical curator during the first two years of study, and a discipline-specific mentor beginning from the third year.

Peer mentors who have undergone specialized training assist first-year students in adapting to the university environment, including everyday, organizational, and extracurricular aspects.

Curators—qualified faculty members of general education departments—provide psychological and pedagogical support, facilitate group cohesion, maintain interaction with parents, and contribute to the formation of students’ values related to engineering education.

Starting from the third year of study, mentorship is transferred to faculty members of the graduating departments, who guide students’ professional development, organize internships, coordinate interaction with industrial mentors, and prepare individualized recommendation profiles for graduates.

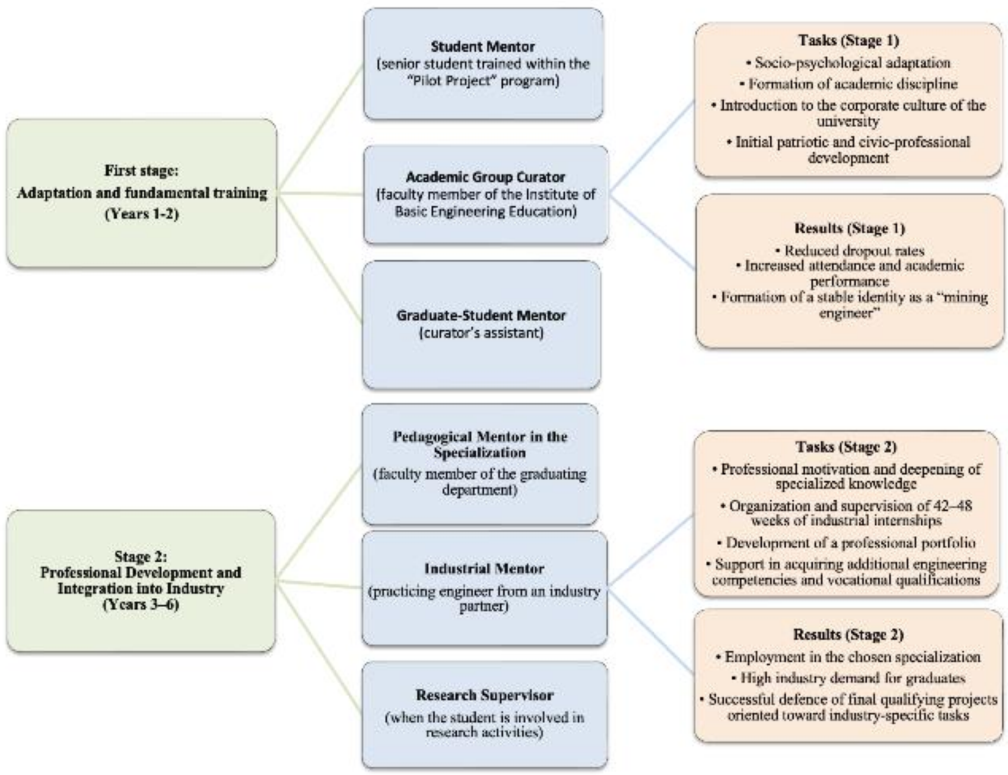

Figure 1. The Mentorship Model of Saint Petersburg Mining University

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The model also integrates graduate students as trainee assistants to curators, emphasizing the continuity of pedagogical competencies and a comprehensive approach to the educational and professional development of future engineers.

The Role of Mentors in Updating Foundational Courses and Providing Academic Support to First-Year Students

One of the key innovative elements of the new model is the integration of mentorship into the educational process. Unlike the traditional approach in which academic advisors do not participate in teaching, at the Mining University the curators serve as leading instructors of the humanities (history, philosophy, foreign languages, etc.) and natural sciences (mathematics, physics, chemistry) during the first two years of study.

This approach enables:

• the early identification of student difficulties in mastering foundational disciplines;

• the provision of additional consultations and analysis of typical problem sets;

• the adaptation of course content to engineering specializations (for example, the mathematics curriculum includes enhanced applied tasks in differential equations relevant to mining engineering);

• the development of students' understanding of the connection between fundamental knowledge and future professional activity.

Thus, the mentor-curator performs a dual role as both an instructor and a developmental advisor. This creates conditions for comprehensive student support and eliminates the traditional divide between instruction and personal development that characterizes the conventional model.

In graphical form, the stages of preparation and practical implementation are presented as a flowchart in Figure 2.

As illustrated in Figure 2, it can be observed that The mentorship program is launched from the first day of a student's enrollment at the university within the framework of a Pilot Project aimed at implementing the new six-year educational program "Higher Engineering Education." The activation of the program is carried out in three stages:

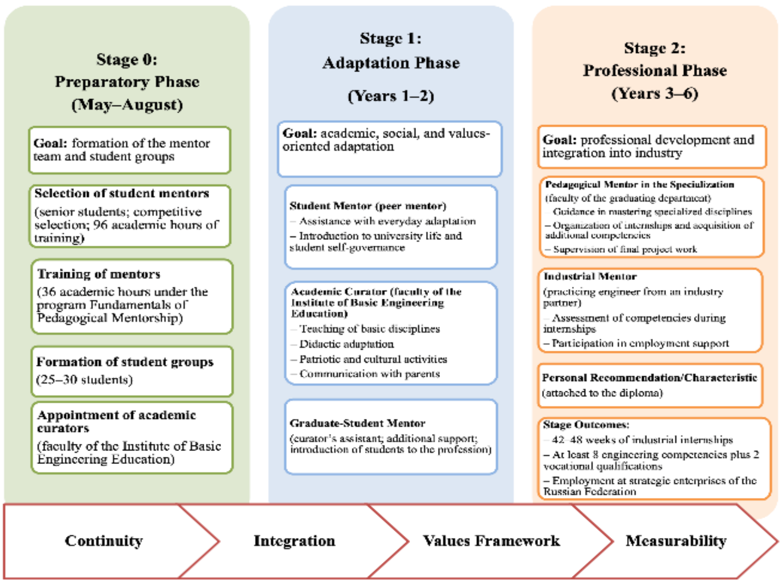

Figure 2. the stages of preparation and practical implementation

- Stage 0 (Preparatory stage, May–August): selection and training of student mentors and academic supervisors; formation of study groups consisting of 25–30 students.
- Stage 1 (Adaptation stage, Years 1–2): implementation of a “triple support” system involving a student mentor, an academic supervisor, and a graduate trainee (PhD student); initiation of activities focused on social, academic, and value-based adaptation.
- Stage 2 (Professional stage, Years 3–6): transition to discipline-specific mentorship with the involvement of faculty members from specialized departments and industry mentors representing partner enterprises.

5. THE MENTORSHIP SYSTEM IN PRACTICE: STRUCTURE, ROLES, AND PERFORMANCE CRITERIA

From the very first day of studies at the university, each group of 25-30 fershmen students is assigned a student mentor from among senior student leaders who have completed special training. These student mentors—peers capable of speaking the same language as first-year students—serve as their initial guides to university life. Their tasks include helping newcomers adapt to the academic environment: complying with the dress code, understanding dormitory regulations, engaging in extracurricular and sports activities, and learning about opportunities for student self-governance and other aspects of campus life.

Elected group leaders (starostas) also undergo special training and certification by the University Council on Pedagogical Competencies. The role of group leaders and the student body at this early stage is difficult to overestimate.

Simultaneously, each student group is supervised by a pedagogical mentor-curator, appointed from among the faculty of the Institute of Basic Engineering Education. During the first two years of study, the curator’s main responsibilities include:

- conducting weekly meetings with the study group (curator hours);
- informing students about scientific, socially significant, academic, patriotic, educational, and other university events;
- assisting with the preparation of student documentation (references, résumés, certificates, student records, etc.) and, where necessary, verification of student achievements in the personal digital profile;
- monitoring academic performance and class attendance;
- attending museums, exhibitions, cultural and sports events together with the study group;
- visiting student dormitories to monitor the quality of living conditions;
- attending classes of the supervised group to observe students’ academic performance and engagement during coursework;
- taking measures in response to violations of internal regulations, when required;
- organizing group activities (excursions, volunteer initiatives);
- interacting with parents or legal guardians, if necessary;
- organizing student participation in career guidance activities aimed at attracting prospective applicants to the University (Open Days, school visits);
- providing support, encouragement, and motivation for students to actively participate in career guidance, sports, creative, volunteer, and other university activities.

Essentially, the curator—working in coordination with the group leader and student mentor—plays a vital role during the first two academic years in instilling in students the core values of Russian engineering education, grounded in the traditions of the Mining University.

Distinctive features of this pedagogical mentorship model, as compared with traditional approaches, include the following:

- Curators are selected from among the most qualified instructors of non-graduating departments (e.g., physical education, Russian language, foreign languages, higher mathematics, etc.), who directly teach general and technical disciplines during the first and second years of study.
- Curators are required to complete training under a specially developed continuing-education program titled “Fundamentals of Pedagogical Mentorship.” This program familiarizes them with the key principles of psychological and pedagogical work with junior students, the development of motivation, patriotic education, and prevention of destructive or unlawful behavior within the student community.
- Postgraduate students (Ph.D. candidates) who have completed similar training and demonstrate an aptitude for teaching are engaged as assistants (interns) to the curators in mentorship activities.

Beginning in the third year, students who have successfully completed the general and technical education modules are assigned a pedagogical mentor in their field of specialization. This mentor, a faculty member of the graduating (specialized) department, supports the student throughout the next four years of study.

Each subject-specific academic mentor is assigned 10–15 students from different academic years enrolled in programs of the graduating department. The main responsibilities of the subject-specific mentor include:

- organizing and supervising students' research activities (for those demonstrating interest and aptitude);
- organizing, guiding, and supervising the preparation of term papers and/or final qualification theses;
- facilitating student participation in discipline-related Olympiads, case championships, exhibitions, conferences, and competitions;
- supporting the acquisition of additional professional competencies and skilled worker qualifications by students;
- organizing and conducting practical training aimed at developing applied industrial skills and experience;
- maintaining close interaction with industry mentors from partner enterprises where students complete internships and industrial placements;
- preparing a personalized graduate reference and recommendation letter, issued as a supplement to the engineering diploma and reflecting all student achievements during their studies at the Mining University;
- providing guidance in selecting future employment opportunities.

Mentoring activities are conducted both individually (through personal consultations) and collectively within mixed groups of students from different academic years sharing the same mentor. Students collaborate on joint scientific or engineering projects and developments (including those based at research centers), while senior students assist junior students in the learning process.

Criteria for Assessing Mentorship Effectiveness:

A separate but critical task involves the development of performance criteria for pedagogical mentors (7).

Based on the core functions of mentors during the first two years and in senior courses, the following key performance indicators (KPIs) are proposed.

For Pedagogical Mentors–Curators (Years 1-2):

- Academic performance: successful completion of the educational program by students or the group (grades, class attendance, percentage of students dismissed for academic failure).
- Discipline and conduct: compliance with internal university regulations and dormitory rules, absence of disciplinary or unlawful incidents.
- Psychological and civic engagement: formation of a positive attitude toward the University and national objectives (voluntary participation in patriotic and volunteer activities, leadership in extracurricular initiatives, membership in student organizations).

For Pedagogical Mentors by Specialization (Years 3-6):

- Academic results: student success in mastering the curriculum (grades, attendance, retention rates).
- Discipline and conduct: adherence to university regulations and codes of behavior.
- Motivation and goal orientation: involvement in scientific research under academic supervision, voluntary participation in industrial practice, engagement in career fairs and other professional-orientation events with academic and industrial partners.
- Professional growth: success in mastering additional engineering competencies, establishing and strengthening professional connections with enterprises, selecting diploma topics relevant to industrial needs, and post-graduation employment in the chosen specialty.

At present, these performance indicators are being incorporated into the pedagogical practice of the Mining University.

The first results confirming the effectiveness of the new mentorship model have been obtained based on the outcomes of the 2024/2025 academic year.

The presented indicators confirm an increase in student and group success rates in mastering the educational program, largely attributable to the growing emphasis placed on mentorship activities.

At the end of the 2024-2025 academic year, an anonymous survey was conducted among both junior and senior students. The questionnaire developed for students of the Saint Petersburg Mining University was comprehensive, combining socio-psychological and educational-analytical dimensions. Its purpose was not only to assess students' attitudes toward the educational process but also to explore their internal motivation, social adaptation, communication habits, and perception of the institutional environment of the university.

The survey covered the following thematic areas:

- socio-psychological adaptation and connection with prior experience;
- motivation and awareness in choosing an educational trajectory;
- attitudes toward the educational process and its various formats;
- perception of the institutional environment and the university's information policy;
- personal growth and self-assessment of learning outcomes;
- social environment and extracurricular engagement.

Most questions were closed-ended with multiple-choice options, which ensured quantitative measurability and enabled statistical analysis of responses.

The survey was based on a student-cantered approach, aiming to capture not merely formal indicators but also subjective perceptions, motivation, and experience. The questions addressed cognitive (knowledge, evaluation), affective (emotions, attitudes), and behavioral (attendance, participation) dimensions of student engagement.

The collected data made it possible to perform an in-depth analysis of student opinions—an essential indicator of the effectiveness of both the educational and developmental components of the university's work. The main findings are summarized below.

1. High Level of Personal Responsibility and Self-Identification among Students

The data indicate that the university's educational and developmental efforts aimed at cultivating personal responsibility and civic awareness are demonstrating high effectiveness.

A vast majority of students—85.3% of juniors and 82.8% of seniors—reported that their choice of specialization was a conscious, independent decision. This finding suggests that the system of career guidance and pre-university preparation (possibly incorporating mentorship elements provided by alumni or teachers) has successfully fostered a mature and self-aware approach to career choice among prospective students.

2. Formation of a Positive University Image and Corporate Identity

One of the key indicators of successful educational work is the formation of student pride in their university and the willingness to share this sentiment with others.

The results show that 71.9% of junior and 61.2% of senior students regularly tell their peers about their studies at the Mining University. This demonstrates a strong sense of corporate identity and a positive institutional image, actively promoted by students within their social environments.

Such behaviour directly reflects the success of the university's educational and value-oriented programs, which foster loyalty and engagement.

3. Potential for Expanding Mentorship through Research Activities

One of the questions that could be raised for this purpose is: ("Have you had the opportunity to become acquainted with the university's scientific and laboratory facilities?") revealed a significant demand for involvement in research.

Among junior students, 16.2% (473 individuals) expressed strong interest in scientific work; among senior students, this figure reached 17.2% (380 individuals).

The mentorship system can and should become a key mechanism to support and develop this interest. Young faculty members, graduate students, or senior-year mentors can organize laboratory tours, "open days," and individualized introductions to research projects. Such initiatives would help cultivate research motivation—an essential component in the formation of future engineers.

4. Positive Dynamics in Personal Development and Group Cohesion

More than 88% of students across all cohorts described the atmosphere within their groups as "good" or "very friendly." Furthermore, over 87% stated that the university had made a significant contribution to their personal and intellectual growth.

This data confirms the presence of a favorable social environment conducive to mentorship implementation: students are already embedded in a positive peer culture and open to collaborative interaction.

Overall, the statistics demonstrate that the university's educational and developmental framework successfully nurtures independence, responsibility, and corporate identity among students.

Building on these results, the mentorship system should be methodologically oriented toward the following strategic directions:

- Personalization of the educational process: transitioning from mass, mandatory formats to individualized guidance, wherein mentors help students discover personal meaning and value in each activity.
- Early integration into research and professional environments: utilizing mentors to bridge the gap between students and research laboratories, while also fostering awareness of the need for additional professional competencies.
- Enhancement of the motivational component: positioning the mentor not as a controller but as a guide, helping students recognize long-term perspectives and the connection between their current activities and future professional careers.

Thus, the survey results not only confirmed the necessity of implementing and expanding the mentorship system, but also clearly outlined the directions in which it can—and must—become the most effective tool for addressing current challenges in the educational and developmental mission of a technical university.

The mentorship model presented in this study is not merely a collection of activities, but a coherent, reproducible, and assessable system integrated into the student's educational trajectory. It addresses several critical contemporary challenges, including the shortage of engineering personnel, the gap between theoretical training and practical application, and the declining level of civic identity among students. Owing to its clear step-by-step structure, institutional support mechanisms, and measurable outcomes, the model may be recommended for dissemination across other technical universities in Russia starting in 2027, as stipulated by Presidential Decree of the Russian Federation No. 343 dated 12 May 2023.

Evaluation of the System's Effectiveness:

The effectiveness of the new mentorship model is confirmed by both quantitative and qualitative indicators.

• According to examination session data, the academic performance of first- and second-year students increased from 76.36% in the 2022/23 academic year (before the Pilot Project launched) to 92.85% in 2024/25.

• An anonymous student survey (more than 5,000 respondents) showed that 85.3% of first-year students made a conscious choice of their specialization, 71.9% would recommend the university to high-school peers, and more than 88% assess relationships within their group as friendly or very friendly.

• The system of performance criteria for pedagogical mentors (curators and specialization mentors) enables an objective assessment of their contribution to students' academic progress, disciplinary culture, and motivational development.

These findings indicate that mentorship is becoming not a formal requirement but an effective mechanism for shaping the engineer of the future—a professional, a citizen, and a patriot.

Thus, the enhancement of higher engineering education through mentorship principles and practices not only aligns with the historical traditions of the Mining University but also fully corresponds to the strategic goals of ensuring the technological sovereignty of the Russian Federation. Further development of this model requires an interdisciplinary approach involving pedagogy, psychology, sociology, and educational management, which opens broad opportunities for research and practical innovation.

To summarize this session, the system for assessing effectiveness is now presented as a three-level framework:

Individual student indicators: academic performance, engagement in research activities and practical training, and employment in the field of specialization.

Mentor performance indicators: assessed according to the criteria specified in Section 4 (academic, behavioral, and motivational).

Institutional metrics: reduction in student attrition rates, growth of corporate identity (based on survey data), and the proportion of graduates employed by strategic enterprises.

6. CONCLUSION

The issue of technological sovereignty is, for contemporary Russia, inseparable from that of national sovereignty, and the central figure in this process is the qualified engineer.

Our country does not suffer from a lack of technologies, but rather from a shortage of engineers capable of implementing these technologies in practice. Unfortunately, the so-called *digital economy*—particularly within the mineral and raw-materials sector—often remains a well-designed presentation, which by its very nature cannot address the full spectrum of engineering challenges.

Mentorship at the Saint Petersburg Mining University continues to serve as a vital instrument for preserving scientific and educational traditions and for preparing competitive specialists for the modern labor market.

Further efforts in this direction are currently focused on:

- assessing the long-term impact of mentorship programs on graduates' career trajectories;
- developing individual educational pathways under the supervision of a disciplinary mentor, based on the *"teacher–student"* principle;
- and strengthening collaboration with industrial mentors from partner enterprises.

Within the framework of the *Pilot Project*, a two-level mentorship system has been developed and implemented. This system spans the entire six-year period of study and integrates developmental, educational, and industrial components. It is based on three fundamental principles:

– continuity of student support,
– integration of learning and practice,
– linking the student's personal well-being with the well-being of Russia.

Prospects for Further Research

The authors identify the following directions for advancing and conceptualizing the mentorship model:

1. Long-term monitoring of graduates' career trajectories to evaluate the influence of mentorship on employment outcomes, professional mobility, and contributions to strategically important industries.
2. Development of methods for personalizing mentorship support.
3. Investigation of the role of mentorship in fostering research motivation among junior students, including interaction with scientific laboratories.
4. Comparative analysis of the effectiveness of different mentorship models in Russian technical universities during the nationwide dissemination of the Pilot Project beginning in 2027.
5. Study of the interaction between university and industrial mentors as a mechanism for transferring up-to-date sectoral expertise into the educational process.

It is anticipated that the continued implementation of mentorship programs at the Mining University will, in the near future, contribute to:

- increased academic motivation and engagement among students;
- the formation of professionally significant competencies;
- accelerated adaptation to educational and professional environments; and
- enhanced competitiveness of graduates in the labor market.

We proceed from the understanding that the advancement of higher engineering education, through the systematic application of mentorship principles and methods, fully aligns with both the historical traditions and the strategic priorities of the Russian Federation.

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Ethics Approval and Consent to Participate

This study did not involve human participants or animals. Therefore, ethical approval and informed consent were not required.

Competing Interests

The authors declare that they have no known financial or organizational conflicts of interest that could have influenced the work reported in this paper.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors used artificial intelligence–based tools to assist with the accurate scientific translation of selected phrases from Russian into English. All translated content was carefully reviewed, edited, and validated by the authors, who take full responsibility for the integrity, originality, and accuracy of the final manuscript.

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Persian Abstract

چکیده

راهنمایی به‌عنوان شکلی از فعالیت آموزشی و تربیتی، در سال‌های اخیر جایگاه ویژه‌ای در نظام آموزش عالی مهندسی یافته است. دگرگونی محیط آموزشی و افزایش نیاز به مهندسانی با شایستگی‌های حرفه‌ای و اجتماعی موجب شده است تا رویکردهای نوینی در زمینه هدایت و پرورش دانشجویان مورد توجه قرار گیرد. فعالیت‌های آموزشی و پرورشی انجام‌شده با دانشجویان بخش جدایی‌ناپذیر فرایند یاددهی–یادگیری محسوب می‌شوند و در پرتو اصلاحات جاری در نظام آموزش عالی، نیازمند نوسازی و بازنگری هستند .در این مقاله، بر اساس تحلیل تجربه‌های برجسته ملی و بین‌المللی در حوزه راهنمایی، مدلی جامع از نظام راهنمایی معرفی می‌شود که در دانشگاه معدنی امپراتریس کاترین دوم سن‌پترزبورگ طراحی و اجرا شده است. این مدل اهداف، اصول و ساختار نظام راهنمایی در بستر دانشگاهی را تعریف می‌کند. دو گروه اصلی از راهنمایان آموزشی، شامل سرپرستان گروه‌های آموزشی و راهنمایان تخصصی، شناسایی شده و مجموعه‌ای از شاخص‌های ارزیابی عملکرد برای آنان پیشنهاد می‌شود. تجربه اجرای این مدل نشان‌دهنده ظرفیت بالای آن در ارتقای مشارکت، انگیزش و رشد حرفه‌ای دانشجویان است