К проблеме профессиональной мобильности будущих инженеров в социокультурной среде вуза

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АННОТАЦИЯ

Введение. Глобальные экономические парадигмы претерпевают радикальные преобразования в условиях Четвертой промышленной революции, для которой характерны технологическая конвергенция и системы интеллектуальной автоматизации. Эта тенденция в сочетании с быстрым технологическим прогрессом усилила социальный спрос на высокомобильных инженерных специалистов. Социокультурная среда университета рассматривается как ключевой фактор в развитии профессиональной мобильности.

Цель исследования – теоретически обосновать, разработать и экспериментально проверить целостную концепцию, структурно-функциональную модель и реализующую ее технологию развития профессиональной мобильности будущих инженеров в социально-культурной среде вуза.

Материалы и методы. В исследовании использовался смешанный подход в течение периода (2004-2024 гг.). Теоретическая фаза включала системный и историко-педагогический анализ литературы по проблемам профессиональной мобильности, инженерного образования и социокультурных сред. Эмпирическая фаза представляла собой масштабный педагогический эксперимент (N=1200 участников, включая студентов, преподавателей и специалистов-практиков из Тюменского индустриального университета [Российская Федерация] и предприятий-партнеров).

Результаты. В результате исследования была разработана авторская целостная Концепция развития профессиональной мобильности будущих инженеров. Ключевым практическим результатом стала Технология реализации этой модели, в частности, через внеучебную программу «Мастерская будущего инженера». Данные об уровнях сформированности профессиональной мобильности будущих инженеров, полученных на констатирующем и контрольном этапах эксперимента, показывает повышение доли высокого уровня во всех трех экспериментальных группах (ЭГ-1, ЭГ-2, ЭГ-3) относительно контрольной группы (КГ). В среднем отмечается повышение высокого уровня в ЭГ-1 и ЭГ-2 в среднем в 2,8 раза, в ЭГ-3 – в 3 раза, тогда как в контрольной группе (КГ) данный показатель возрос в 2,1 раза. При сравнении контрольной группы (КГ) с экспериментальными группами (ЭГ-1, ЭГ-2, ЭГ-3) с использованием критерия Пирсона (χ^2) были получены следующие показатели: КГ и ЭГ-1: значение χ^2 = 7,9770; КГ и ЭГ-2: значение χ^2 = 8,5599; КГ и ЭГ-3: значение χ^2 = 14,2834. Значение χ^2 для КГ и ЭГ-3 (14,2834) является существенно более высоким по сравнению с значениями для других групп. Различия между КГ и ЭГ-1, а также КГ и ЭГ-2, вероятно, менее выражены, при этом результат для КГ и ЭГ-2 незначительно выше, чем для ЭГ-1. Таким образом, экспериментальное вмешательство оказало наиболее значительный и измеримый эффект в ЭГ-3, что подтверждается наибольшим значением критерия χ^2 в её сравнении с КГ.

Дискуссия. Полученные результаты согласуются с глобальными образовательными тенденциями, подчеркиваемыми ЮНЕСКО, которые выступают за развитие универсальных навыков (soft skills) будущих специалистов. Исследование демонстрирует, что целенаправленное педагогическое воздействие в рамках социокультурной экосистемы вуза.

Заключение. Исследование подтверждает гипотезу о том, что развитие профессиональной мобильности будущих инженеров является эффективным, если оно носит системный, концептуально обоснованный характер и интегрировано в социокультурную среду вуза.

КЛЮЧЕВЫЕ СЛОВА

профессиональная мобильность, инженерное образование, социокультурная среда вуза, педагогическая концепция, компетентностный подход, педагогическая технология, будущие инженеры

Для цитирования: Баликаева М. Б. К проблеме профессиональной мобильности будущих инженеров в социокультурной среде вуза // Перспективы науки и образования. 2026. № 2. С. 160–172. https://doi.org/10.32744/pse.2026.2.9

Поступила: 25.10.2025 | Одобрена: 12.12.2025 | Опубликована: 30.04.2026

To the Problem of the Professional Mobility of Future Engineers in the Social-Cultural Environment of a University

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ABSTRACT

Introduction. Global economic paradigms are undergoing radical transformation in the wake of the Fourth Industrial Revolution, characterized by technological convergence and smart automation systems. The trend has coupled with rapid technological advancements, has intensified the social demand for highly mobile engineering professionals. The social-cultural environment of a university is posited as a critical factor in fostering this professional mobility.

The study aims to theoretically substantiate, develop, and experimentally test a holistic Concept, a structural-functional Model, and an implementation Technology for the professional mobility development of future engineers within the social-cultural environment of a university

Materials and methods. This research employed a mixed-methods approach over a 20-year period (2004-2024). The theoretical phase involved a systematic and historical-pedagogical analysis of literature on professional mobility, engineering education, and social-cultural environments. The empirical phase consisted of a large-scale pedagogical experiment (N=1200 participants, including students, faculty, and industry specialists from Industrial University of Tyumen [the Russian Federation] and partner enterprises. Diagnostic methods included questionnaires, testing, interviews, expert evaluation, and analysis of academic and professional outcomes. A conceptual model and a corresponding pedagogical system were developed and tested.

Results. The study resulted in the development of an original, holistic concept for developing professional mobility in future engineers. A key practical output was the technology for implementing this model, notably through the extracurricular program "Workshop of Future Engineers." The experimental data on the development of professional mobility in future engineers, collected during the initial and final stages of the experiment, demonstrate a significant increase in the high proficiency level across all three experimental groups (EG-1, EG-2, EG-3) compared to the control group (CG). Specifically, the high level increased by an average factor of 2.8 in EG-1 and EG-2, and by a factor of 3 in EG-3, whereas the control group showed only a 2.1-fold increase. Statistical analysis using Pearson's chi-square test ($\chi2$) revealed the following values for group comparisons: CG and EG-1: $\chi2 = 7.9770$; CG and EG-2: $\chi2 = 8.5599$; CG and EG-3: $\chi2 = 14.2834$. The substantially higher $\chi2$ value for the CG-EG-3 comparison (14.2834) indicates the most significant intervention effect in EG-3. The differences between CG and both EG-1 and EG-2 appear less pronounced, though the effect in EG-2 marginally exceeds that in EG-1. These results confirm that the experimental intervention was most effective in EG-3, as evidenced by the highest $\chi2$ value in its comparison with the control group.

Discussion. The findings align with global educational trends emphasized by UNESCO, which advocate for the development of transferable skills (soft skills). The research demonstrates that targeted pedagogical intervention within the university's social-cultural ecosystem.

Conclusions. The research confirms the hypothesis that the professional mobility development of future engineers is effective when it is systemic, conceptually grounded, and integrated into the social-cultural environment of the university.

KEYWORDS

professional mobility, engineering education, social-cultural environment of a university, pedagogical concept, competence-based approach, pedagogical technology, future engineers

For Citation: Balikaeva, M. B. (2026). To the Problem of the Professional Mobility of Future Engineers in the Social-Cultural Environment of a University. *Perspektivy nauki i obrazovania = Perspectives of Science and Education*, (2), 160–172. https://doi.org/10.32744/pse.2026.2.9

Received: 25 October 2025 | Approved: 12 December 2025 | Published: 30 April 2026

INTRODUCTION

The Fourth Industrial Revolution, characterized by cyber-physical systems, artificial intelligence, and rapid technological convergence, is fundamentally reshaping global industries and labor markets. In this dynamic landscape, the role of the engineer is evolving from a specialist executing standardized tasks to an innovative problem-solver, a project leader, and a lifelong learner. Global organizations, from the World Economic Forum to UNESCO, consistently highlight the growing demand for "future skills" — including adaptability, complex problem-solving, and cross-cultural competencies — over purely technical knowledge. According to UNESCO's 2021 report "Engineering: Issues, Challenges and Opportunities for Development," the Fourth Industrial Revolution is transforming the role of the engineer from a technical specialist into an adaptive problem-solver and leader, necessitating a shift towards future skills like complex problem-solving and cross-cultural competencies [1]. In alignment with the article by Mohd Kamaruzaman et al., the Fourth Industrial Revolution is transforming the role of an engineer from a technical specialist into a versatile professional who must possess future skills such as adaptability, complex problem-solving, and cross-cultural competencies [2]. Drawing on the discourse of the Fourth Industrial Revolution, which prioritizes adaptive problem-solving and cross-functional competencies over specialized technical knowledge, this thesis by M.B. Balikaeva investigates the crucial imperative of fostering agile, lifelong learning capabilities in engineering education to meet the demands of the evolving global labor market [3]. This paradigm shifts places immense pressure on higher engineering education systems worldwide to move beyond knowledge transmission and foster a new professional quality: professional mobility.

Professional mobility is understood in this research as an integrative personal quality characterized by a high level of universal and professional competencies. It enables an individual to design vertical and horizontal routes of professional socialization and adapt to transformations in the professional environment [3]. For an engineer, this signifies the readiness and ability to change specializations, master adjacent fields, assume managerial roles, and continuously update one's knowledge base in response to technological shifts [4].

The modern university is not merely a knowledge-transfer institution but a complex social-cultural environment – a space for interaction, communication, and co-creation where students' value consciousness, moral qualities, and professional competencies are formed [3]. This environment, particularly its extracurricular dimension (student clubs, associations, project groups, centers for youth initiatives), possesses significant but often underutilized potential for developing the non-technical competencies essential for mobility [Ibid.].

Despite the acknowledged importance of professional mobility, a review of contemporary pedagogical literature reveals a significant research gap.

The problem of developing professional mobility specifically for engineers remains under-theorized and lacks a comprehensive pedagogical framework [Ibid.]. Key terms such as "professional mobility of future engineers," and "social-cultural environment of a technical university" lack precise definitions and operationalization within a cohesive system. Furthermore, existing approaches often focus either on psychological training or on narrow aspects of curriculum modernization without integrating these elements into a holistic system that leverages the entire university ecosystem [5].

There is a lack of a unified theoretical and methodological foundation that systemically integrates the potential of the university's social-cultural environment for the specific purpose of the professional mobility development of engineering students. The mechanisms, pedagogical conditions, and effective technologies for this process have not been sufficiently developed or experimentally validated.

The study aim: The aim of this article is to theoretically substantiate, develop, and experimentally test a holistic concept, a structural-functional model, and an implementation technology for the professional mobility development of future engineers within the social-cultural environment of a university.

This aim was achieved through a long-term research project utilizing theoretical analysis (historical, comparative, systemic) and empirical methods (pedagogical experiment, observation, testing, expert assessment). The core of our approach was the design of a pedagogical system based on systemic, competence-based, and integrative-developmental methodological approaches, which was then implemented and evaluated for effectiveness.

REVIEW

The modernization of higher education, driven by global economic integration and rapid technological advancement, has shifted the paradigm of engineering training. Beyond the acquisition of specialized knowledge, there is a growing social demand for graduates who are adaptable, innovative, and capable of navigating dynamic career paths. This review analyzes two central concepts in this paradigm: professional mobility as a target quality of a modern engineer, and the social-cultural environment of a technical university as a primary factor in its development. The purpose of this review is to synthesize existing research, highlight the interrelationship between these concepts, and identify gaps in the literature.

Professional Mobility: Evolution of the term and its structural components. The term of "mobility" has roots in sociology, notably with Pitirim Sorokin's theory of social mobility, which described the movement of individuals within a social structure [6]. The term "professional mobility" emerged later, in the mid-20th century, as sociologists began to systematically analyze occupational structures and career pathways. Seminal work was conducted by S. Lipset and R. Bendix [7], who explored the relationship between social stratification, industrialization, and mobility patterns. Their research was foundational in establishing professional mobility as a distinct field of sociological inquiry. Subsequently, P. Blau and O. Duncan [8] made a significant contribution by developing sophisticated statistical models to analyze occupational mobility and the factors influencing an individual's career trajectory, thereby providing a more empirical and structural understanding of the phenomenon. Initial Definitions: early interpretations often equated professional mobility with vertical (career advancement) or horizontal (change of profession or workplace) movement within the social and professional structure of society [9]. It was viewed primarily as a social phenomenon.

Psychological and Pedagogical Perspectives: later research shifted towards understanding professional mobility as an integral personal quality. Scholars like B. M. Igoshev [10] and V. V. Novikov [11] define it as a formed readiness and ability of an individual to change their professional role, status, and activities based on a system of knowledge, values, and needs. This reframing moved the focus from the fact of change to the personal capacity for change.

According to M. V. Votintseva [12] the motivational component of professional mobility, encompassing the need for self-development and readiness for change, can be cultivated through the integrated teaching of a foreign language. L. P. Merkulova [13] posits that the operational-activity component of professional mobility, which includes practical communication and adaptive skills, is effectively formed in technical specialists through the means of foreign language education. N.Ya. Rosenfeld and V.A. Maltseva [14] analyze the reflexive component of professional mobility, arguing that the ability to self-assess and strategically design one's career trajectory is a critical factor determining the social mobility and success of university graduates.

This evolution shows a transition from a purely sociological interpretation to a holistic, person-centered understanding of professional mobility as a key competence for the 21st-century engineer.

Comparison with other scholars:

1. B. M. Igoshev considers professional mobility as an "integral quality of an individual, encompassing readiness and ability to change professional status, based on value orientations, knowledge, and needs" [10].

Similarity with our definition: emphasis on integrality and personal qualities.

Difference: we place greater emphasis on competencies and social transformation, whereas B.M. Igoshev focuses on adaptability.

2. L. V. Goryunova defines professional mobility as "the ability of an individual to adapt quickly to the changing demands of the labor market through mastering new knowledge and technologies" [15].

Similarity that it emphasis on adaptation and continuous learning.

Difference that we expand the definition by including cultural and social context.

3. E. F. Zeer links professional mobility to "key qualifications that enable a specialist to switch between types of activities without loss of efficiency" [16].

Similarity: importance of competencies and flexibility.

Difference: we add the aspect of professional socialization and influence on the environment.

4. S. A. Kugel emphasizes "professional mobility as a social-structural phenomenon reflecting the dynamics of specialists' movements within the professional sphere" [17].

Similarity: attention to social aspects.

Difference: we view mobility as a personal quality, not merely a structural phenomenon.

Common features: all definitions emphasize adaptability, competencies, and personal qualities.

Uniqueness of our definition: it more deeply integrates the term of professional culture; includes the active role of the engineer in transforming the professional environment; places emphasis on designing career paths (vertical/horizontal).

Thus, our definition synthesizes the approaches of previous researchers, complementing them with social-cultural and systemic components, which reflects modern requirements for engineering education.

MATERIALS AND METHODS

The social-cultural environment of a technical university as a developmental factor.

The term of the "educational environment" is well-established in pedagogical theory. The social-cultural environment of a university is a broader term, encompassing the entire reality of the university's life where value consciousness, moral qualities, and professional competencies are formed through interaction, communication, and co-creation [18; 19].

According to A. D. Zharkov [20], the socio-cultural environment is a sphere of cultural and leisure activity that encompasses informal practices and is subject to specific pedagogical technologies and design.T. V. Kuznetsova [21] views the socio-cultural environment as a key condition for a child's personality development, emphasizing the optimization of its informal and non-formal aspects. V.A. Smirnov [22] analyzes the socio-cultural environment of a university through the lens of youth policy and educational activities, highlighting the role of student self-government, clubs, and the general psychological climate as essential non-formal components. It is a "dominant area for future graduates" [3].

Specifics of a technical university: research indicates that the social-cultural environment of a technical university has distinct characteristics:

1. A microenvironment saturated with engineering values: it fosters a corporate culture that values precision, innovation, and professional ethics [3; 23].

2. Orientation towards professional development: it is intentionally designed to develop not just knowledge, but also soft skills and adaptive qualities (e.g., through business games, project competitions, hackathons).

3. Integration with Industry: a defining feature is the close connection with industrial partners through base departments, joint projects, and practices, which immerses students in their future professional culture.

4. The challenge of "Clip Thinking": the modern digitalized environment requires new approaches to engage students and develop deep critical thinking alongside digital literacy.

The literature suggests a strong synergistic relationship between these two concepts. The social-cultural environment is not a background factor but an active agent in developing the components of professional mobility.

Motivational Development: student clubs, scientific communities ("Workshop of Future Engineers"), and success stories from industry partners create an atmosphere of achievement and stimulate the need for self-realization and career growth [3].

Cognitive and Operational Development: project-based activities within the environment (e.g., in student business incubators) force students to integrate knowledge from different disciplines, solve real-world problems, and develop teamwork and management skills-directly contributing to the operational-activity component [10].

Reflexive Development: participation in cultural events, international clubs, and interdisciplinary discussions broadens horizons, fosters critical thinking, and helps students understand their place in the professional world, thereby enhancing reflection.

Our research demonstrates that the targeted use of this environment, for example, through foreign language self-education in a club format, significantly improves the effectiveness of forming professional mobility.

Despite a solid foundation, several gaps remain:

1. Empirical Validation: while theoretical models are well-developed, there is a need for more large-scale empirical studies that quantitatively measure the correlation between specific activities within the socio-cultural environment and the level of developed professional mobility.

2. Digital Environment: the impact of fully digitalized socio-cultural environments (virtual clubs, online communities, MOOCs integration) on professional mobility requires further investigation.

3. Cross-Cultural Studies: most research is focused on the Russian context. comparative studies across different national systems of technical education could provide valuable insights.

This study was conducted over four stages from 2004 to 2024, following a sequential exploratory design:

Stage 1 (2004-2007): Preparatory. Analysis of philosophical, sociological, psychological, and pedagogical literature to define the problem field, conceptual apparatus, and methodological base.

Stage 2 (2008-2011): Diagnostic. Clarification of the hypothesis and research tools. Study of the current state of professional mobility among students and the potential of the university environment. Development of the initial research concept.

Stage 3 (2012-2015): Formative. Development and initial апробация of the proposed Concept, Model, and pedagogical technology. Implementation of the experimental program and collection of qualitative and quantitative data.

Stage 4 (2016-2024): Control and Generalization. Finalizing the experiment, conducting statistical analysis, interpreting results, integrating findings into educational practice, and formulating final conclusions.

The experimental work involved a total of 1200 participants: primary diagnostic Stage (N=1000): 636 undergraduate students from the "Construction" major at Industrial University Tyumen (IUT); 200 students from other universities in Tyumen and neighboring regions (Tobolsk, Khanty-Mansiysk, Kurgan, Tomsk); 164 industry specialists.

Formative Experiment (N=200): 130 students (1st-4th years); 45 university teachers; 25 specialists from construction enterprises.

Experimental Base. The research was conducted primarily at Industrial University of Tyumen (IUT).

Methods and Tools. A complex of complementary methods was used:

Theoretical Methods. Systematic and comparative analysis of literature; conceptual-terminological analysis; synthesis; generalization; modeling.

Empirical Methods. Pedagogical Experiment (ascertaining, formative, control stages).

Diagnostic Tools. Author-developed questionnaires to assess motivation, knowledge, and skills; tests to measure cognitive and operational components; expert evaluation sheets for assessing project activities; interviews with students and employers.

Statistical Methods. Quantitative and qualitative analysis of empirical data, including methods of mathematical statistics for processing results and verifying their reliability.

The "Workshop of Future Engineers" Program. The core of the experimental intervention was the implementation of the author's program "Workshop of Future Engineers" within the social-cultural environment of IUT. This program integrated:

Special Course: "Development of Professional Mobility of Future Engineers."

Project-Based Learning: Students worked on real-world projects from partner enterprises.

Foreign Language Self-Education: Focus on professional English for engineering, business correspondence, and technical communication.

Interactive Methods: Business games, case studies, trainings, masterclasses with industry professionals.

MOOC Integration: Utilization of Massive Open Online Courses to expand knowledge beyond the standard curriculum.

Data from questionnaires and tests were processed to identify levels of professional mobility (low, medium, high) based on three criteria: motivational, cognitive-operational, and procedural-activity. The results of the experimental and control groups were compared to determine the effectiveness of the proposed pedagogical system.

RESULTS

The Conceptual Framework. The research resulted in the development of an original Concept for developing professional mobility. Its core ideas are:

It is based on a triad of methodological approaches: systemic (providing a holistic view), competence-based (defining the target outcome), and integrative-developmental (ensuring practical implementation).

It identifies a set of pedagogical patterns and corresponding principles (e.g., principles of goal-setting, integration, professional direction, complementarity, feedback, individuality).

It defines professional mobility as an integrative quality with a structure comprising:

Structural Elements: Universal (UC), General Professional (GPC) and Professional (PC) Competencies as defined by the Federal State Educational Standard.

Functional Elements: Motivational (needs, aspirations, readiness for self-transformation); Structural-Content (ability to acquire new knowledge/technologies); Reflective-Activity (awareness of one's potential and ability to transfer knowledge to new situations).

The Structural-Functional Model. The Concept is operationalized through a five-component Model:

1. Theoretical-Content Component: Defines the goals, content, and competencies to be developed.

2. Design-Developmental Component: Involves the planning and organization of the educational process within the social-cultural environment.

3. Motivational Component: Aimed at stimulating students' interest and need for self-development and mobility.

4. Activity-Reflexive Component: The core of practical activity where students engage in projects, reflection, and self-assessment.

5. Evaluative-Corrective Component: Provides continuous monitoring, diagnosis, and correction of the process.

This model is characterized by reproducibility, adaptability, continuity, and student-centeredness.

Experimental Findings. The formative experiment confirmed the effectiveness of the proposed system. The study involved three experimental groups (EG-1 – 33 students, EG-2 – 31 students, EG-3 – 32 students) and one control group (CG – 34 students) with 130 participants. Comparative analysis of data from all experimental groups and the control group before and after the intervention showed statistically significant progress across all EGs.

Key Results: motivational criterion: The number of students with high motivation levels increased by 2.8 times in EG-1 and EG-2, and by 3 times in EG-3, compared to 2.1 times in CG. Cognitive-operational criterion: all experimental groups (EG-1, EG-2, EG-3) demonstrated significantly better ability to acquire new information from foreign sources and analyze technical problems. Performance on standardized tests improved by an average of 35% compared to CG. Procedural-activity criterion: all EGs (EG-1, EG-2, EG-3) showed superior results in practical project activities and teamwork. Expert assessments from industry partners were significantly higher for experimental groups' project presentations. Statistical analysis: chi-square (χ^2) tests revealed significant differences between CG and all EGs: CG and EG-1: $\chi^2 = 7.9770$; CG vs EG-2: $\chi^2 = 8.5599$; CG vs EG-3: $\chi^2 = 14.2834$.

The distribution of students across proficiency levels showed decisive shifts toward "High" and "Medium" in all experimental groups, while CG demonstrated minimal change (Table 1).

Table 1 Distribution of students by level of Professional Mobility Formation (%)

Group	Level	Ascertaining Stage	Control Stage
EG-1	High	12.3	34.5
	Medium	45.1	48.9
	Low	42.6	16.6
EG-2	High	11.8	35.5
	Medium	45.3	48.7
	Low	42.9	15.8
EG-3	High	12.5	37.5
	Medium	44.8	49.2
	Low	42.7	13.3
CG	High	11. 9	25.1
	Medium	44.9	46.1
	Low	43.3	28.8

The results demonstrate that the experimental intervention was most effective in EG-3, as evidenced by the highest χ^2 value, confirming the positive correlation between program comprehensiveness and development of professional mobility.

One of the feature of the "Workshop of Future Engineers" Program is to teach communication in English considering corporate culture, working with business and technical documentation in English, and delivering project presentations. The program provides an overview of effective job search and interview techniques and introduces the specifics of working in an engineering company using examples from local enterprises. Each section of the program is accompanied and reinforced with examples, primarily from companies in the Tyumen region (e.g., PJSC "LUKOIL", PJSC "GAZPROM", "NK "Rosneft" (PJSC), etc.). To motivate students, representatives from companies such as "Schlumberger" and PJSC "GAZPROM" were invited to give lectures for the lessons.

To research the level of professional motivation among future specialists, a survey of students was conducted. The results revealed that 91% of students were interested in learning business English. Students will be able to acquire the necessary knowledge in business English. When selecting topics for the program, we also relied on student opinion. According to the student survey, the following topics were included:

1. Effective job search techniques (introduction to an engineering company; company tour);

2. Types of companies (structure of an engineering company; examples and descriptions of company structures);

3. Interview preparation (interview etiquette; resume and short biography; cover letter);

4. Working in an engineering company: roles and responsibilities;

5. Working on a project (planning; meeting; discussion; contract; documentation: technical drawing, estimate; project improvement proposals);

6. Equipment: quality; ordering; delivery; malfunction and repair;

7. Corporate culture (company policy);

8. Presentation techniques (presentation structure; presentation tools).

According to M. B. Balikaeva [24], G. Ya. Grevtseva [Ibid.], R. A. Litvak [Ibid.] topics such as corporate culture, digital presentation techniques, and project documentation are integral components of the information and digital culture that are crucial for the successful socialization of future engineers in a professional environment. The research by A. Çal [25] and W. Admiraal [Ibid.], which analyzes the real language needs of engineers in Turkey, confirms the practical importance of mastering topics related to job search techniques, company structures, and interview preparation for effective performance and communication in the engineering workplace.

The next stage involved surveying students about their motivation. A mixed-format questionnaire was developed (featuring closed-ended questions – single and multiple choice – and open-ended questions). The distribution of motivating factors for choosing the course was as follows (Table 2).

Table 2 Student motivation for choosing the elective course

Motivating Factor	Student Choice (%)
Personal interest	70
Contribution to their future	68
Cognitive interest	76
New information presented in a non-standard way	20
Instructor flexibility (ability to identify student needs, adjust the course	78
Self-development	37
New information	25
Variety of class formats	34
Communication with new people	15

Thus, students associate their choice of elective primarily with their personal interests and personal development (70% of responses), followed by 68% of students choosing electives related to their future professional activities.

In particular, 76% of students noted the cognitive nature of the program. For 20% of students, the information presented was new and delivered in an unusual way. Notably, the instructors of the elective were rated quite highly by students: the ability to be flexible and grasp the audience's needs.

Therefore, all evaluated factors were rated exclusively positively: each student finds what is a priority for them. A significant advantage is that the program invites students from different fields of study. And the difference in mastering the material is almost imperceptible, meaning the students themselves motivate each other to achieve personal results.

Based on the practical part of the survey results, it can be concluded that the "Workshop of Future Engineers" program receives grateful support from students and is aimed at training future in-demand specialists in the region. Furthermore, instructors have the opportunity to work with a highly motivated audience, use non-standard or active teaching forms, and realize their professional and personal interests.

DISCUSSION OF RESULTS

The results of this study confirm the central hypothesis and align with global trends in engineering education. The focus on developing broad competencies and adaptability resonates with the recommendations of UNESCO and the World Federation of Engineering Organizations (WFEO), which call for engineers who are innovators, lifelong learners, and responsible global citizens [1].

The significant growth in professional mobility in the experimental group can be attributed to the systemic nature of the intervention. The Model successfully integrated formal education (through the special course) with non-formal learning in the social-cultural environment (the "Workshop"). This synergy provided both the theoretical foundation and the practical "sandbox" where students could safely experiment, fail, reflect, and develop crucial soft skills. The emphasis on foreign language professional self-education proved particularly valuable, as it directly enhances access to global knowledge and international communication, a key aspect of modern mobility [24; 25]. The effectiveness of the social-cultural environment as a developmental factor supports the theories of V. A. Slastyonin [26]. The club format ("Workshop of Future Engineers") reduced psychological barriers, fostered collaboration, and created a community of practice that extended beyond the classroom, which is consistent with the findings of J. Lave, E. Wenger on situated learning [27].

Comparison with previous research. According to O. Yu. Malakhova [5], A. N. Popov [Ibid.], A. A. Khandrimailov [Ibid.], the educational environment of a technical university unlocks its potential through integrative courses and research work, which are crucial for the sociocultural self-determination and development of human capital in a future engineer. B.M. Igoshev [10] substantiates the paramount importance of a system-integrative approach to organizing the educational process, viewing it as a fundamental condition for developing a professionally mobile specialist. L. P. Merkulova [13] emphasizes that integrative courses, particularly those incorporating a foreign language, are an effective means of forming the professional mobility of technical specialists. However, it moves beyond by embedding these elements into a holistic system that is explicitly housed within and powered by the university's social-cultural environment, a factor less emphasized in previous studies. It also provides a more structured definition and diagnostic apparatus for professional mobility itself, addressing a terminological vagueness noted in the literature.

The proposed technology, particularly the use of MOOCs and digital platforms (like IUT's Educon), offers a modern solution to the challenge of keeping curriculum content current with rapidly evolving industries, a problem highlighted by many educators. J. Kidd, D. Rhemer, K. Gutierrez et al. [28] investigate the engineering-related knowledge and beliefs of PSTs in their first education course, collaborating in small teams to lead elementary students in engineering design challenge. M.S. Ramírez-Montoya, M. Portuguez-Castro et al. research high-capacity training to prepare competent students to solve complex problems using for complex thinking skills [29].

Further contemporary research continues to explore various dimensions of professional development, often leveraging modern technologies. For instance, studies by B. A. Alabadan, M. S. Taiwo et al. [32] demonstrate the application of digital monitoring systems for assessing practical skills in technical education. Ya. Tsekhmister, T. Konovalova, B. Tsekhmister et al. [33] provide valuable insights into the effectiveness of virtual reality simulations for forming professional competence, highlighting the broader potential of immersive technologies. Additionally, M. F. Murillo Manrique, Jo. A. Sánchez Ayte [34] emphasize the advantages of using artificial intelligence for personalizing educational trajectories in higher education, a finding that supports the broader move towards adaptive and technologically-enhanced learning environments explored in our research.

This study was conducted primarily within the context of construction engineering in a specific Russian regional university. While the core Concept and Model are designed to be adaptable, further research is needed to test their applicability to other engineering disciplines (e. g., IT, robotics) and in different cultural and institutional contexts.

Longitudinal studies tracking the career paths of graduates from the experimental group would provide even more robust evidence of the long-term impact of this intervention on professional mobility and career success.

CONCLUSION

The source base of the present study was the regulatory documents presented at the beginning of our study. They are in the field of education and national policy documents of the Russian Federation (RF) and abroad.

This comprehensive research project addressed a critical gap in the pedagogy of higher technical education by developing a scientifically grounded framework for cultivating professional mobility in future engineers. The study concludes that:

1. The professional mobility of future engineers is a complex, integrative quality that can and should be purposefully developed within the university environment.

2. The social-cultural environment of a technical university is a powerful but underutilized resource for this development, offering a space for practical application, collaboration, and personal growth that complements formal education.

3. The proposed concept, model, and technology form an effective pedagogical system for achieving this goal. The system is based on sound methodological principles and is confirmed by experimental data to significantly enhance students' motivation, cognitive abilities, and practical readiness for a dynamic professional life.

4. The integration of foreign language self-education, project-based learning, and digital resources into a cohesive extracurricular program (e.g., "Workshop of Future Engineers") is a highly effective technological implementation of the proposed model.

In essence, the research demonstrates that fostering professional mobility requires a shift from a purely knowledge-centric model of education to a student-centric, ecosystem-based model that prepares engineers not just for their first job, but for a lifelong career of adaptation, learning, and innovation.

ACKNOWLEDGMENTS

The author expresses sincere gratitude to the scientific consultant, Professor G.Ya. Grevtseva, for her invaluable guidance. Gratitude is also extended to the administration and staff of Industrial University Tyumen for the support in organizing and conducting the pedagogical experiment.

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Баликаева М. Б.: концептуализация, методология, верификация данных, формальный анализ, проведение исследования, создание черновика рукописи, создание рукописи и её редактирование

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Автор заявляет об отсутствии конфликта интересов

The author declared no conflicts of interest