



# IJTIMOYIY-GUMANITAR SOHADA ILMIY-INNOVATSION TADQIQOTLAR

ILMIY METODIK JURNALI

ISSN 3060-5059



**VOL.3 № 4**

**2026**

## **MUHANDISLIK TA'LIMIDA "MATERIALSHUNOSLIK VA KONSTRUKSION MATERIALLAR TEXNOLOGIYASI" FANINI O'QITISHNING METODIK TIZIMI MODELINI ISHLAB CHIQISH**

**Dauletov Kalniyaz Abatbayevich**  
Nukus davlat texnika universiteti, professor

### **Annotatsiya**

Ushbu maqolada muhandislik ta'limi tizimida asoslangan "Materialshunoslik va konstruksion materiallar texnologiyasi" fanini o'qitishning zamonaviy pedagogik yondashuvlarga asoslangan holda metodik tizimi modeli ishlab chiqish bo'yicha asosiy ma'lumotlar muhokama qilinadi. Muallif ta'lim jarayonlarining asosiy maqsadi, metodik tizim modelining o'qitish texnologiyasidagi asosiy mazmuni, ta'lim jarayonlarida amalga oshirilayotgan innovatsion yondashuvlarning umumiy tahlili va pedagogik tadqiqotlarning natijalariga asoslangan komponentlarini tizimli yondashuv asosida birlashtirishni taklif etadi. Shuningdek, pedagogik yondashuvlarning zamonaviy tahlil natijalariga ko'ra, ta'lim jarayonlarida pedagogik metodlarga asoslangan tizimli model kompetentlikga asoslangan mulohazalar, ta'lim faoliyatining samaradorligini oshirish, talabalarning aksiologik dunyoqarashini shakllantirish va shaxsga yo'naltirilgan yondashuvlarga asoslangan holda, nazariy bilimlarni amaliy faoliyat bilan uyg'unlashtiradi. Ushbu metodik tizim asosan texnika yo'nalishlarida tahsil oluvchi muhandislik kadrlarini tayyorlashda ta'lim samaradorligini oshirishga xizmat qiladi.

**Kalit so'zlar:** Pedagogik metodlar, o'qitish texnologiyasi, materialshunoslik, metodik tizim, innovatsion metodlar, muhandislik ta'limi, modellashtirish, kompetentlik yondashuvi, pedagogik yondashuvlar.

## **РАЗРАБОТКА МОДЕЛИ МЕТОДИЧЕСКОЙ СИСТЕМЫ ПРЕПОДАВАНИЯ ДИСЦИПЛИНЫ "МАТЕРИАЛОВЕДЕНИЕ И ТЕХНОЛОГИЯ КОНСТРУКЦИОННЫХ МАТЕРИАЛОВ" В ИНЖЕНЕРНОМ ОБРАЗОВАНИИ**

**Даулетов Калнияз Абатбаевич**  
Нукусский государственный технический университет, профессор

### **Аннотация**

В данной статье рассматриваются ключевые аспекты разработки модели методической системы преподавания дисциплины "Материаловедение и технология конструкционных материалов" в системе инженерного образования на основе современных педагогических подходов. Автор предлагает системно объединить основную цель образовательного процесса, ключевое содержание модели методической системы в технологии обучения, общий анализ инновационных подходов, реализуемых в образовательном процессе, а также компоненты, вытекающие из результатов педагогического исследования. Кроме того, согласно современному анализу педагогических подходов, эта системная модель, основанная на педагогических методах, гармонично сочетает теоретические знания с практической деятельностью. Такая интеграция опирается на компетентностный подход, повышение эффективности учебной деятельности, формирование аксиологического мировоззрения студентов и применение личностно-ориентированных подходов. Данная методическая система в первую очередь служит повышению эффективности образования при подготовке инженерных кадров, обучающихся по техническим направлениям.

**Ключевые слова:** Педагогические методы, технология обучения, материаловедение, методическая система, инновационные методы, инженерное

образование, моделирование, компетентностный подход, педагогические подходы.

## DEVELOPMENT OF A MODEL OF THE METHODOLOGICAL SYSTEM FOR TEACHING THE DISCIPLINE “MATERIALS SCIENCE AND TECHNOLOGY OF STRUCTURAL MATERIALS” IN ENGINEERING EDUCATION

**Dauletov Kalniyaz Abatbayevich**  
Nukus State Technical University, Professor

### Abstract

This article discusses the fundamental aspects of developing a methodological system model for teaching the subject "Materials Science and Technology of Structural Materials" within the engineering education system, based on modern pedagogical approaches. The author proposes a systematic integration of several components: the primary objective of the educational process, the core content of the methodological system model within teaching technology, a general analysis of innovative approaches implemented in educational processes, and components derived from the results of pedagogical research. Furthermore, according to a contemporary analysis of pedagogical approaches, this system-based model, founded on pedagogical methods, integrates theoretical knowledge with practical activities. This education relies on approaches based on integrative competence, increasing the effectiveness of educational activities, shaping students' axiological worldview, and applying personality-oriented approaches. This methodological system primarily serves to increase the effectiveness of education based on the training of engineering personnel studying in technical fields.

**Keywords:** Pedagogical methods, teaching technology, materials science, methodological system, innovative methods, engineering education, modeling, competency-based approach, pedagogical approaches.

Engineering education, as a key direction of technological progress and one of the central areas of modern educational innovation, primarily requires the training of specialists capable of combining theoretical knowledge in technology with real learning practice. The content of the discipline “**Materials Science and Technology of Structural Materials**” is formed on the basis of the principles of increasing scientific rigor, ensuring consistency in education, and maintaining both continuity and practical orientation in the teaching of technology. From the standpoint of content, maintaining a balance between theoretical knowledge and practical training is essential for increasing educational effectiveness. In this way, students are given the opportunity to reinforce theoretical understanding through real experience.

This discipline includes mechanisms for organizing the educational process within the learning environment of higher educational institutions. Indicators of the educational effectiveness of pedagogical research conducted in these processes are determined on the basis of modern innovative mechanisms of teaching forms, pedagogical methods, and instructional technologies. In educational practice, alongside traditional lecture-based and seminar-based instruction, it is recommended to use methods grounded in modern pedagogical technologies, including problem-based learning, interactive methods, project-based instruction, and research-oriented teaching approaches.

The project-based learning method is particularly important in engineering education, as it encourages students to engage in independent inquiry and develops their creative thinking abilities. Traditional forms of teaching engineering disciplines in higher education institutions remain predominantly academic, while modern industrial production sectors are increasingly being penetrated by technological systems based on advanced technologies. As a result, the need for engineers capable of rapidly adapting to digitally transformed production environments has

become especially significant [1, p. 8; 12].

In practical pedagogical research conducted in the field of education in the Republic of Uzbekistan and in other developing industrial regions, considerable attention is paid to the organization of engineering competencies in materials science education, especially within the subject “**Technology of Structural Materials.**” Its methodological modernization is of great importance for improving the quality of education and adapting it to industry standards [2, p. 25].

The main objective of this research is to develop a scientifically grounded model of a methodological system that ensures a holistic pedagogical process by integrating theoretical, practical, and research activities in engineering education in the field of technology. This educational model reflects global trends in engineering pedagogy, and its contribution to the digital transformation of education is based on applied research examined within the framework of the present study [3, p. 30].

The theoretical and methodological foundations of engineering education in pedagogy are revealed through an expanded analysis. The development of a methodological system for teaching the subject “**Materials Science and Technology of Structural Materials**” is based on the integration of theoretical and methodological principles that determine the logic, content, and organization of the educational process. The theoretical foundation draws on both pedagogical theories and modern concepts of engineering education, emphasizing systems thinking, competence development, and digital transformation in the learning environment [4, p. 41].

In modern pedagogy, a methodological system represents a holistic construct that unites the goals, content, methods, and results of teaching into a single self-developing structure. Its design must correspond not only to didactic requirements but also to the socio-technological context of engineering education. Therefore, the model proposed in this study integrates several complementary approaches—systemic, competency-based, activity-based, axiological, and learner-centered—each contributing to the integrity and adaptability of the educational process [5, p. 54].

### **The Systems Approach as a Structural Foundation**

The systems approach serves as the conceptual basis of the methodological model. It views the teaching process as an open, dynamic system with interconnected elements, internal feedback, and self-regulating mechanisms.

In the context of **Materials Science and Technology of Structural Materials**, a systems approach allows for:

- identifying the relationships between material structure, teaching methods, and professional competencies;
- establishing a hierarchy among learning objectives, content modules, and expected outcomes;
- creating continuous feedback loops between teaching, student activity, and learning outcomes [6, p. 60].

Such an organization ensures the integrity of the educational process, strengthens the connection between theoretical and practical knowledge, and supports the manageability of competency development. Furthermore, systems thinking develops in students the ability to analyze complex engineering systems, which is a vital skill for future specialists.

### **The Competency-Based Approach as a Goal-Oriented Foundation**

The competency-based approach defines the goal orientation of the model. It interprets learning outcomes not as fragmented knowledge, but in terms of professional competencies. For students in engineering specializations, this means mastering:

- fundamental theoretical understanding of the properties and transformations of materials;
- practical skills in applying this knowledge to the design, production, and maintenance of engineering systems;
- soft skills such as teamwork, communication, and digital literacy [7, p. 72].

Competency-based education requires the reorganization of curricula, shifting from content-based instruction to outcomes-based instruction, where each educational module contributes to the formation of measurable results.

In the teaching of **Materials Science and Technology of Structural Materials**, this is demonstrated through laboratory and project work aimed at solving real-world production problems, selecting materials, and optimizing processing technologies. Through these activities, students develop a systematic understanding of how theoretical knowledge functions in production and innovation contexts [8, p. 85].

#### **The Activity-Oriented Approach as a Process Component**

The activity-oriented approach provides the procedural foundation for the model. It focuses on learning through purposeful, productive activity, which corresponds to L.S. Vygotsky's idea that intellectual development occurs through social and practical interaction.

For engineering disciplines, this means creating a learning environment in which students are actively involved in experimentation, modeling, and solving technological problems.

In the course **Materials Science and Technology of Structural Materials**, this approach is implemented through:

- laboratory experiments studying the microstructure and stress states of materials;
- modeling of real technological processes using software such as ANSYS, MATLAB, and SolidWorks;
- collaborative design projects integrating knowledge from mechanics, physics, and chemistry [9, p. 90].

An activity-based system transforms students from passive recipients of information into co-creators of professional knowledge. It also cultivates engineering thinking—the ability to model, design, predict, and optimize—which forms the foundation of technical creativity.

#### **Axiological and Learner-Centered Approaches as Humanistic Dimensions**

The axiological (value-oriented) and learner-centered approaches complement the systemic and competency-based paradigms by addressing the humanistic and ethical aspects of engineering education.

Axiology, in an educational context, ensures that professional training also fosters moral responsibility, environmental awareness, and respect for safety standards—qualities that are essential in industrial and technological settings [10, p. 95].

The learner-centered approach, in turn, personalizes the educational process. It recognizes that students differ in their prior knowledge, motivation, and pace of learning. Therefore, the methodological system includes flexible assignments, elective modules, and individual projects that allow each learner to explore specific interests in materials science and engineering design.

Digital educational technologies support this personalization through flexible learning pathways and real-time progress tracking.

#### **Integration of Approaches and Theoretical Synthesis**

The uniqueness of the proposed model lies in the synergy of these methodological approaches. The systems approach ensures structural integrity; the competency-based approach defines goals and expected outcomes; the activity-oriented approach determines methods and technologies of teaching; and the axiological and learner-centered principles support motivation, values, and self-development.

Together, they form a methodological synthesis that transforms the teaching of **Materials Science and Technology of Structural Materials** from a traditional subject into a comprehensive educational system integrating scientific knowledge with personal and professional development [11, p. 101].

This theoretical foundation allows the subsequent stages of model construction—analytical, design, and implementation—to be built on clear methodological logic. It also ensures

that the system can evolve and adapt in response to changes in educational standards, technological innovations, and societal needs.

### **Structure of the Methodological System**

The proposed system includes four components:

1. **Objective component** – defining educational outcomes aligned with professional standards and industry needs [9, p. 90].
2. **Content component** – integrating theoretical, practical, and applied knowledge related to materials and technologies.
3. **Process component** – incorporating digital and interactive teaching methods, laboratory experiments, and project-based learning [10, p. 95].
4. **Outcome component** – focusing on assessment, competency identification, and continuous feedback.

The integrity of these components ensures the harmonious development of students' cognitive, operational, and motivational domains [11, p. 101].

### **Stages of Model Development**

The creation of the methodological system was carried out in three interconnected stages:

1. **Analytical-diagnostic stage** – identifying the discrepancies between traditional teaching and modern industrial requirements.
2. **Design stage** – constructing the theoretical model and defining methodological approaches.
3. **Implementation stage** – piloting, evaluating, and adapting the model for institutional use [12, p. 112].

Each stage, supported by feedback mechanisms and data analysis, ensures scientific validity and pedagogical effectiveness [13, p. 121].

### **Mechanism of Operation and Self-Development**

The methodological system functions as a dynamic, self-developing model consisting of interacting subsystems:

- **Pedagogical subsystem** – managing educational goals and content;
- **Information subsystem** – providing digital and informational resources;
- **Motivational subsystem** – supporting student activity and engagement;
- **Assessment subsystem** – monitoring and improving teaching effectiveness [14, p. 128].

The model operates cyclically: **planning** → **organization** → **implementation** → **evaluation** → **adjustment** → **development**.

This ensures stability, self-regulation, and long-term adaptability to scientific and technological changes [15, p. 134].

### **Practical Application of the Model**

The model was introduced on an experimental basis at the Department of Mining and Metallurgy of Nukus State Technical University.

The course “**Materials Science and Technology of Constructional Materials**” was redesigned on the basis of the proposed methodological system.

The main features of the implementation included:

- creating a modular structure for the course;
- integrating laboratory and project-based learning;
- using virtual simulations for materials testing;
- applying competency-oriented assessment criteria.

The results showed a significant improvement in students' motivation, analytical skills, and ability to apply theoretical knowledge in practical settings.

Employers also noted a higher level of satisfaction with graduates' readiness to work in industry [16, p. 140].

### **Pedagogical Conditions for Effective Functioning**

The effectiveness of the model depends on a number of pedagogical conditions:

1. **Qualified teaching staff** – instructors trained in digital tools and modern pedagogy.
2. **Material and technical resources** – laboratories equipped with modern equipment and software.
3. **Integration with industry** – collaborative relationships with manufacturing enterprises for practice-oriented education.
4. **Digital educational environment** – platforms for e-learning, data visualization, and simulation.
5. **Continuous feedback and reflection** – monitoring educational outcomes and adapting teaching accordingly [17, p. 147].

These conditions ensure stability, flexibility, and high educational quality.

### **Prospects for Further Research**

Future work may be directed toward:

- extending the model to other engineering disciplines such as mechanical engineering, metallurgy, and nanotechnology;
- introducing artificial intelligence and machine learning into the educational process;
- developing international cooperation and comparative research in engineering pedagogy;
- studying the impact of digital transformation on the evolution of professional competencies.

The developed system can serve as a pedagogical platform for innovation in technical universities, promoting global competitiveness and lifelong learning.

Engineering education plays a decisive role in societal development, serving as one of the principal driving forces behind modern production, technological progress, and the innovative economy. The practical application of applied research, especially in rapidly developing technical and industrial fields, should not only provide engineers with deep theoretical knowledge, but also enhance their ability to acquire practical skills, develop analytical thinking, solve problems, and master innovative approaches at the required level.

From this perspective, the subject “**Materials Science and Technology of Structural Materials**” is of particular importance, since it is aimed at studying the structure of materials used in production, as well as their physicochemical properties and processing technologies. This subject includes not only theoretical knowledge, but also the pedagogical and methodological foundations for transferring such knowledge into practical experience.

Therefore, relying solely on traditional teaching methods is insufficient; rather, it requires the use of modern pedagogical approaches, innovative technologies, and a systematic methodological model. It is this necessity that makes the development of an effective methodological system for this discipline in engineering education a highly relevant issue.

The primary task of materials science is to study the internal structure of materials and the changes occurring within them under external influences. The technology of structural materials, in turn, encompasses methods of processing these materials, their use in production, and the related technological processes. The integration of these two fields contributes to the formation of a comprehensive body of knowledge in students. For this reason, it is important to apply a systematic approach to teaching these subjects.

The concept of a methodological system involves viewing all components of the pedagogical process—goals, content, methods, resources, and outcomes—in their interrelation. This system serves to increase the effectiveness of the educational process.

When developing a methodological system based on innovative pedagogical research for engineering education, the following main factors must be taken into account: analysis of modern industrial requirements, evaluation of the level of technological development, examination of students’ preparedness, and assessment of the material and technical base of the educational institution. Experimental and practice-based learning should also be incorporated to enable

students to acquire new knowledge through research.

One of the main components of the methodological system for teaching the subject **“Materials Science and Technology of Structural Materials”** is the accurate definition of its goals and objectives. The main educational objective of the subject is to provide students with in-depth knowledge of the physical properties, chemical composition, and mechanical characteristics of materials, as well as their structure and technological processing. Moreover, to enable students to apply this knowledge in practice, it is necessary to develop their skills in making informed decisions when selecting materials and optimizing technological processes.

The next important element of the methodological system is the relationship between content and instructional method. Content reflects the body of knowledge studied within the discipline. The content of **“Materials Science and Technology of Structural Materials”** primarily includes the study of crystalline structure, allotropic states, phase transformations, the properties of metals and alloys, heat treatment, melting processes, pressure treatment, welding, mechanical processing, and modern technologies of composite materials.

Teaching methods are among the most vital components of the methodological system. In modern engineering education, the widespread use of interactive methods, problem-based learning, project-based approaches, case-study methods, and digital technologies is strongly recommended. For example, when students are engaged in solving real production-related problems, their independent thinking develops more effectively. Laboratory sessions also play an important role in reinforcing theoretical knowledge.

Furthermore, the proper implementation of teaching resources within a methodological system based on pedagogical research is of great importance. Well-organized teaching resources make the educational process more effective and engaging, deepen students' knowledge, and develop their practical skills.

When developing a methodological system model, special attention should also be paid to the outcomes component. Educational outcomes are evaluated through students' knowledge, skills, and competencies. In materials science, the primary focus is on students' ability to analyze materials, determine their properties, and choose the most suitable material for a specific application. At the same time, students must possess sufficient knowledge to understand and optimize technological processes.

When developing such a methodological system model, it is advisable to apply a competency-based approach alongside a systemic pedagogical approach. These approaches direct students not only toward acquiring engineering knowledge, but also toward applying it in professional practice.

### **Conclusion**

In conclusion, the developed model of the methodological system for teaching the subject **“Materials Science and Technology of Structural Materials”** provides a comprehensive approach to engineering education by integrating digital tools, production practice, and innovative pedagogical approaches grounded in pedagogical theory. Its structure, consisting of goal-oriented, content-based, processual, and outcome-related components, ensures the integrity and flexibility of education. Its practical implementation confirms its effectiveness in developing professional competencies, strengthening student motivation, and producing innovative pedagogical outcomes.

### **REFERENCES**

1. Kholmurodov D. S. Bo'lajak muhandislar uchun materialshunoslik va konstruksion materiallar texnologiyasini o'qitish metodik tizimi modeli // European Journal of Research and Reflection in Educational Sciences. — 2020. — 8-jild, 8-son.
2. Kanivets O. V. va boshqalar. Metall qattiqligini o'lchashni o'qitishda kengaytirilgan reallik elementlariga ega virtual laboratoriya ishlari // Journal of Physics: Conference Series. — 2025. — 3105-jild, 1-son.
3. Kurbaniyazova M. R. va boshqalar. Qoraqalpog'istonda fan va ta'lim. — ISSN 2181-9203.

4. Tsarenko O. M. Materialshunoslikni o'rganishda bo'lajak mehnat ta'limi o'qituvchilarining kasbiy kompetensiyalarini shakllantirish // Naukoviyy zapiski. Pedagogika fanlari seriyasi. — 2019. — 183-son. — B. 42–46.
5. Bavrovskaya N. M. va boshqalar. Zamonaviy sharoitlarda bo'lajak mutaxassislarni kasbiy tayyorlash. — Baltija Publishing, 2025.
6. Abduraxmanova Z. T. Muhandislik ta'limida pedagogik modellar. — Nukus: NSTU, 2019. — B. 30.
7. Petrov I. V. Kompetensiyaga asoslangan ta'limning metodologik asoslari. — Moskva: Akademiya, 2020. — B. 25.
8. Dyakov A. S. Ta'lim jarayonlarining tizimli tahlili. — Qozon: University Press, 2017. — B. 41.
9. Beknazarov R. K. Texnik oliy ta'lim muassasalarida faol o'qitish metodlari. — Olmaota: Texnika, 2016. — B. 54.
10. Sharipova M. G. Muhandislik ta'limida metodik tizimlarni modellashtirish. — Samarqand: University Press, 2020. — B. 90.
11. Ernazarov D. N. Texnik ta'limni modernizatsiya qilish muammolari. — Toshkent: Universitet, 2021. — B. 95.
12. Abdullayeva N. K. Kompetensiyalarni shakllantirishning pedagogik shartlari. — Buxoro: Buxoro universiteti nashriyoti, 2022. — B. 101.
13. Dosmukhamedov K. U. Muhandislik ta'limining axborot va raqamli muhiti. — Astana: Science, 2019. — B. 112.
14. Djumaniyazov O. R. Materialshunoslikni o'qitishda tizimli yondashuv. — Nukus: NSTU, 2018. — B. 121.
15. Xalmuradov S. P. Muhandislik pedagogikasida innovatsion texnologiyalar. — Toshkent: Fan, 2020. — B. 134.
16. Dauletov K. A. "Materialshunoslik va konstruksion materiallar texnologiyasi" fanini o'qitish metodikasi. — Nukus: NSTU Press, 2024. — B. 147.
17. Dauletov K. A. Texnik oliy ta'lim muassasalarida "Materialshunoslik va konstruksion materiallar texnologiyasi" fanini o'qitishni takomillashtirishning metodologik asoslari // International Journal of Formal Education. — 2025. — 4-jild, 12-son. — B. 133.
18. Dauletov K. A. Raqamlashtirish sharoitida muhandislarning kasbiy kompetensiyalarini shakllantirish // Ta'lim tizimida ijtimoiy-gumanitar fanlar. — Toshkent, 2026. — B. 56.