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Methodology For Solving Key Problems Through Non-Standard Solutions In The Training Of Future Engineers

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ABSTRACT

This methodology aims to address key problems in the training of future engineers through non-standard solutions. The approach focuses on developing students' creative and critical thinking, enabling broader problem analysis, integrating interdisciplinary knowledge, and emphasizing applied project design. The design-thinking stages include: problem framing, ideation, prototyping, testing, analysis, and iteration. By selecting real-world problems in the learning process, working in groups on open-ended questions, building prototypes, and using CAD and simulation tools, knowledge is translated into practice. Assessment is conducted with rubrics based on indicators such as creative thinking, problem analysis, prototyping skills, results analysis, active participation in teamwork, and self-assessment. The expected outcome is that future engineers will be able to find effective solutions even in non-routine situations, work productively in interdisciplinary teams, and demonstrate flexible, innovation-oriented thinking.

Keywords: Non-standard solutions; engineering education; future engineers; design thinking; applied project design; interdisciplinary integration; problem analysis; prototyping; simulation; CAD tools; team collaboration; open-ended questions; innovative thinking; adaptability.

INTRODUCTION

The process of creative problem solving by future engineers is accompanied by the manifestation of certain characteristics of creative activity: independently transferring knowledge, qualifications, skills, and competencies to a new situation; recognizing a new problem in a familiar situation; independently combining known methods for action in a new context; constructing a fundamentally new method of solution different from known ones; and combining known solution methods.

In the training and instruction of future engineers, it is planned—according to the State Educational Standards—to develop the following physics-related competencies in students:

1. the competency to observe, understand, and explain physical processes and phenomena;

2. the competency to conduct experiments, measure physical quantities, and draw conclusions;

3. the competency to apply physical knowledge and devices in practice.

To develop the professional preparedness of future engineers, the use of non-standard tasks within an integrative approach can be implemented through solving various problems in physics, for example by working through typical problems. By a "typical problem" we mean goals that are posed repeatedly in certain real-life situations. In J. E. Usarov's doctoral dissertation, typical problems that can be solved by applying one's knowledge of physics in professional activity and everyday conditions are grouped into the following types: creating objects with specified properties; developing the technology (method) for solving a concrete problem; eliminating deviations of an object's parameters from specified norms; preserving an object without changing its given properties or transporting it from one place to another; finding or evaluating the physical parameters that characterize an object in a specified state; controlling the operation of an object and its technological process; and operating a technical object.

Let us present some of the typical problems that future engineers encounter in their daily work—problems solvable by applying their physics knowledge—and use them to generate non-standard tasks.

Creating Objects with Given Properties:

1. To keep certain types of fish in an aquarium, the water temperature must be 30 °C. Design a device that maintains this temperature constantly in the aquarium.

2. For houseplants, soil moisture must always remain within a specified range. While you are away on vacation, design a device that keeps this moisture level stable.

3. In many places, there are interruptions in the electricity supply. What can be done to prevent food from spoiling in the refrigerator?

4. Invent a device that allows the front door to close gently (for children) without requiring much force.

5. Propose a device that gives a pleasant audible alert when newspapers or letters are placed into the mailbox.

Developing the Technology (Method) for Solving a Specific Problem:

1. In many refrigerators, the freezer compartment becomes thickly covered with frost and ice. Devise a way to defrost it quickly.

2. As is well known, eyes water when onions are chopped. Propose methods to avoid this.

3. Roads outside are icy. Recommend safety methods for going to and from school (college).

4. The weighing scale at home has a maximum capacity of 5 kg. How can you measure a 10 kg object with it?

5. You want to move heavy furniture from one place to another inside the house. Propose a way to reduce friction in this case.

6. Propose methods to slow down the evaporation of liquids.

Eliminating Deviations from Specified Norms in Object Parameters:

1. How can you check that there is no short circuit in an electric kettle?

2. If the humidity in your room is high, how can you bring it back to normal?

3. How can unpleasant odors from household pets be eliminated?

Preserving an Object's Given Properties Without Change, or Transporting It from One Place to Another

1. One summer day, the household refrigerator broke down. Until it is repaired, how can food be kept from spoiling?

2. You arrive at a country house on a hot summer day. How would you store food without a refrigerator?

3. It is necessary to take hot food to a patient in the hospital. How can it be delivered hot without a thermos?

Finding or Evaluating the Physical Parameters that Characterize an Object in a Given State

1. You have a 0.8-liter glass jar. Can it hold 1 kg of honey?

2. How can the strength of a synthetic fiber (nylon fishing line) used for making a fishing rod be determined?

3. Is it possible to determine the depth of a well while standing on the ground surface?

4. How can room temperature be estimated without a thermometer?

Controlling the Operation of an Object or a Technological Process

1. In an Uzbek folk tale, a stepmother mixes a sack of mung beans with a sack of corn kernels and tells a girl to

separate them in one night. Help devise a method to separate them.

2. Invent a device that controls the temperature in an electric tandoor.

3. Design a device that regulates the water and gas flow in a gas-heated water heater.

Operating a Technical Object

1. Write out the sequence of actions to perform when replacing a printer cartridge.

2. Describe what can be done to record more information on a disk than its nominal capacity.

3. Find a way to charge a mobile phone in a place without access to electrical power—such engaging, engineering-oriented tasks are presented here. [1, p. 58].

In physics classes, interdisciplinary connections with history are often used, and learners write reports or summaries about one scientist or another. This type of work does not allow students to feel the historical period, to see the conditions that enabled the development of the phenomenon being studied, or to understand the consequences of its practical application. Therefore, in integrated lessons, we recommend focusing on the "posing problem questions" method and gradually increasing the number of unconventional tasks. This method can also be used as homework before starting to study a topic. For example:

1. What historical events prompted the invention of the atomic bomb?

2. What consequences (environmental, historical, economic) resulted from the use of nuclear weapons in Hiroshima and Nagasaki?

3. Which historical events confirm that A. S. Popov was the first to discover radio communication?

Several key problems are considered in the process of training future engineers. Here they are, along with brief recommendations:

1. Issues of curriculum content and quality: Curricula do not keep pace with rapidly changing technology. There is a lack of resources for textbooks and laboratory work. There are uncertainties related to certification/accreditation requirements.

Recommendations: Introduce outcome-based education; familiarize students with hybrid (multidisciplinary) pathways; continuously update accreditation requirements.

2. Practical skills and laboratory opportunities: Insufficient laboratories, production sites, and prototyping tools. A lack of internships and practical exercises.

Recommendations: Implement project-based learning (capstone) in cooperation with industry; establish company laboratories or mobile labs; expand the use of simulation and prototyping tools.

3. Industry linkage and mismatch with the labor market: An incomplete understanding of workforce needs and a mismatch in employment. Insufficient internships, mentoring, and on-the-job training.

Recommendations: Create an annual industry council or advisory board; provide students with clear pathways to employment; make internship programs mandatory.

4. Financial and infrastructure constraints: Insufficient funding for laboratory equipment, software, and technological infrastructure; limited access to online resources and accreditation.

Recommendations: utilize government–treasury and private-sector grants, PPP projects, open-source tools, and low-cost/high-value software.

5) Shortage of personnel and inclusivity issues: A lack of qualified instructors and difficulty attracting young specialists. Constraints for women, low-income students, or those from rural regions.

Recommendations: international exchanges for teacher upskilling, motivational grants, and the launch of inclusivity programs.

6) Safety, ethics, and labor regulations: Insufficient preparation in safety for practicals. Inadequate education on ethics, safety, and responsible engineering.

Recommendations: standard safety courses, hands-on safety practice, and ethics seminars.

7) Assessment and outcome tracking: Competency-based

assessment is not sufficiently used. It is difficult to track graduates' employment and satisfaction indicators.

Recommendations: regularly measure KPIs such as employment rates, internship success, and company evaluations.

What solutions can be used?

Strengthen industry–higher education links: advisory councils, internship agreements formalized by protocol, and cooperative programs.

Expand project-based learning: students develop through projects that solve real-world problems.

Modernize infrastructure: contemporary lab equipment, simulators, open-source software, and digital platforms.

Continuous professional development for teachers and specialists: workshops, international exchanges, and online courses.

Financial support: government grants, private-sector investments, and scholarship programs.

Social inclusivity: special programs for students from rural areas, and targeted incentives and pathways for women.

CONCLUSION

A methodology for solving problems through non-standard solutions in the training of future engineers serves not only to deepen theoretical knowledge but also to cultivate creative thinking, systematic analysis, collaboration, and a culture of safety. Examining problems with context-appropriate approaches, integrating multiple disciplines, and implementing prototyping and testing stages ensure that future specialists adapt quickly to real production environments. Classes should be interactive, project-oriented, and based on interdisciplinary collaboration, thereby developing students' independence, teamwork skills, and logical decision-making. Through industry partnerships, hackathons, and real projects in laboratory work, learners can generate innovative solutions; the assessment system should be focused on both process and final results and be balanced across indicators.

REFERENCES

1. Usarov J.E. Tayanch fanga oid kompetensiyalar asosida ta'lim mazmunini takomillashtirish va o'quvchilar kompetentligini rivojlantirish. Ped. fan. d-ri (DSc). Avto. – T.:, TDPU, 2004. –16 b.
2. Коменский Я. А. Избранные педагогические сочинения / Под ред.А. А.Красновского / Я. А.Коменский. – М.:,1955., -655 с.
3. Ушинский К. Д. Собрание сочинений / К.Д.Ушинский / Гл.ред.А.М. Еголин / – М.:, 1950. -779 с.
4. Makletsov S. V., Khabibullina G. Z., Starshinova T. A. Formation model of information competence of bachelors specializing in mathematics & computer sciences. Journal of Organizational Culture. 2016;20(S2):173- 179.