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PRINCIPLES OF STEM EDUCATION IN THE CONTEXT OF INCREASING MOTIVATION OF INSTRUMENTATION STUDENTS AT A TECHNICAL UNIVERSITY UNDER DISTANCE LEARNING CONDITIONS

In the article, the author explores current issues in the training of students at a technical university, particularly in the faculty of instrumentation engineering, under the conditions of distance learning. In today's world, where technology is rapidly advancing, education must meet new challenges by equipping students with the necessary skills and knowledge. This is especially true for instrumentation students, who must be ready to work with the latest technologies. One approach that can significantly enhance the effectiveness of education is STEM education. The main principles of STEM education discussed in the article include the integration of disciplines, problem-based learning, practical application of knowledge, development of 21st-century skills, innovation and creativity, personalized learning approaches, as well as collaboration and teamwork. These principles make STEM education an effective tool for preparing students for a future where technology and science will play a key role.

The author analyzes factors influencing motivation. She also proposes methods to enhance motivation, including interactive teaching methods, involvement in research activities, individual educational trajectories, and encouragement of achievements. The article presents the results of a survey conducted among students of the Igor Sikorsky Kyiv Polytechnic Institute, which helped identify factors affecting motivation to study higher mathematics and methods to enhance it. The conclusions of the study emphasize the importance of professional motivation, which includes economic prospects, innovative development, quality of education, social recognition, opportunities for self-realization, and global mobility. Therefore, the implementation of STEM education principles in distance learning can significantly enhance the motivation of instrument engineering students to acquire the knowledge and skills necessary for successful professional activities.

Key words: *motivation, instrumentation students, STEM education, higher mathematics, innovative thinking, professional prospects, distance learning, interdisciplinary approach.*

(статтю подано мовою оригіналу)

In the modern world, where technology is rapidly advancing, education must meet new challenges by equipping students with the necessary skills and knowledge. This is particularly true for instrumentation students, who must be prepared to work with the latest technologies. One approach that can significantly enhance the effectiveness of education is STEM education (Science, Technology, Engineering, Mathematics). In the context of distance learning, which has become particularly relevant due to wartime conditions, the application of STEM education principles can greatly increase student motivation.

The purpose of this article is to explore the current issues in preparing engineering students at a technical university, particularly in the instrumentation faculty, under the conditions of distance learning, to consider the principles of STEM education as a means of enhancing the motivation of instrumentation students, and to analyze the factors affecting educational and professional motivation and methods of its enhancement.

STEM education is an approach to learning that integrates these four disciplines into a cohesive learning process focused on the practical application of knowledge. The main principles of STEM education include:

1. Integration of Disciplines: – STEM education combines science, technology, engineering, and mathematics into a single curriculum, allowing students to see the connections between these fields. This enhances the understanding of how knowledge from different disciplines can be applied to solve real-world problems.
2. Problem-Based Learning: – Students engage in solving real problems, which stimulates their creativity and innovation. This approach encourages critical thinking and analytical skills necessary for solving complex tasks.
3. Practical Application of Knowledge: – STEM education emphasizes the practical use of theoretical knowledge. Students participate in laboratory work, projects, and experiments, which helps them better understand the material and see its application in the real world.
4. Development of 21st Century Skills: – STEM education promotes the development of skills important in the modern world, such as critical thinking, creativity, collaboration, communication, and digital literacy. These skills are key for a successful career in many fields.
5. Innovation and Creativity: – Engineering students are encouraged to develop new ideas and solutions, stimulating their creativity. STEM education supports an innovative approach to learning, allowing students to experiment and discover new ways to solve complex technical problems.
6. Individualized Learning Approach: – STEM education often employs personalized learning methods that take into account the individual abilities and interests of students at a technical university. This helps to increase motivation and engagement in the learning process.
7. Collaboration and Teamwork: – Future engineering professionals work in teams, developing their collaboration skills and ability to work in a group.

This is important for preparing to work in a modern multidisciplinary environment.

These principles make STEM education an effective tool for preparing students of higher education institutions in Ukraine for a future where technology and science will play a key role.

Students' learning motivation is a combination of internal and external factors that encourage them to actively acquire knowledge, develop skills, and achieve academic goals. It includes interest in the educational material, the desire to achieve high results, the awareness of the significance of education for future professional activities, as well as the influence of the social environment, such as teachers, peers, and family.

Learning motivation is a key factor that determines the effectiveness of the educational process and student success. The learning motivation of instrumentation students is an important aspect that determines their success in professional development and preparation for future careers. Identifying and supporting student motivation are key tasks for educational institutions that strive to ensure high-quality education and training of specialists. This article examines the main factors influencing the learning motivation of instrumentation students and methods for enhancing it.

Factors affecting the learning motivation of engineering students include:

– Interest in the profession: Students who choose the "instrumentation engineering" specialty due to a personal interest in technical sciences and engineering usually have a higher level of motivation. Interest in the profession stimulates them to actively acquire the knowledge and skills necessary for a successful career.

– Practical application of knowledge: Understanding how theoretical knowledge can be applied in practice is a powerful motivator. Laboratory work, internships, and other forms of practical activities help students see the results of their efforts, which increases their interest in learning.

– Professional prospects: Awareness of employment opportunities and career growth is also an important motivating factor. Information about the successful careers of graduates and the demand for specialists in the field of instrumentation can encourage students to study more diligently.

– Support from teachers and mentors: Positive interaction with teachers who can engage students and support them in their studies is an important element of motivation. Openness to new ideas, an individual approach, and a willingness to help contribute to creating a favorable learning environment.

Methods to enhance the learning motivation of future engineering professionals include:

– Interactive teaching methods: The use of modern technologies and interactive methods, such as simulations, virtual laboratories, and project-based learning, can significantly increase students' interest in the educational process.

– Involvement in research activities: Participation in scientific projects and conferences allows students to feel part of the scientific community and stimulates their further development.

– Individual educational trajectories: Providing students with the opportunity to choose subjects and research directions according to their interests contributes to increased motivation.

– Encouragement and recognition of achievements: Recognizing students' successes, both academically and personally, is an important stimulus for further development.

As a specific example, let us analyze the significant factors influencing the educational motivation of instrumentation students to study higher mathematics at the Igor Sikorsky Kyiv Polytechnic Institute, as well as methods to enhance it.

A survey was conducted by the author, a lecturer from the Department of Mathematical Physics and Differential Equations, among second-year students of the groups PB-31, PB-32, and PK-31 specializing in "Automation, Computer-Integrated Technologies, and Robotics" at the Faculty of Instrumentation Engineering (FIE). Here is an example of a 10-question questionnaire that was proposed to students to investigate the motivation of instrumentation students (FIE) to study higher mathematics at the Igor Sikorsky Kyiv Polytechnic Institute:

1. Why did you choose the "Instrumentation" specialty at KPI?
a) Personal interest in technical sciences;
b) Influence of relatives or friends;
c) Employment prospects;
d) Other (please specify).
2. How do you assess the importance of higher mathematics in your specialty?
a) Very important;
b) Moderately important;
c) Slightly important;
d) Not important.
3. Which aspects of higher mathematics do you find most challenging?
a) Algebra;
b) Mathematical analysis;
c) Differential equations;
d) Geometry;
e) Probability and mathematical statistics;
f) Other (please specify).
4. Do you feel that proficiency in higher mathematics increases your competitiveness in the job market?
a) Yes;
b) No;
c) I don't know.

5. How would you rate your level of motivation to study higher mathematics?
a) Very high;
b) High;
c) Average;
d) Low;
e) Very low.
6. What factors most influence your motivation to study higher mathematics?
a) Personal interest;
b) Influence of lecturers;
c) Curriculum requirements;
d) Support from classmates;
e) Other (please specify).
7. Do you participate in additional mathematics classes or clubs?
a) Yes, regularly;
b) Sometimes;
c) No, never.
8. Do you think the university provides sufficient educational resources for studying higher mathematics?
a) Yes, completely sufficient;
b) Sufficient, but could be better;
c) Insufficient;
d) Not provided at all.
9. Do you plan to use higher mathematics knowledge in your future career?
a) Yes, definitely;
b) Possibly;
c) No.
10. What changes do you think could enhance your motivation to study higher mathematics?
a) Improvement of teaching methods;
b) More interactive materials;
c) Increase in practical sessions;
d) Other (please specify).

This questionnaire helped to better understand the various aspects of students' motivation to study higher mathematics and identify possible ways to improve the educational process. Analyzing the conducted student survey, the following conclusions can be drawn [1]. The motivation of instrumentation students (FIE) to study higher mathematics at the Igor Sikorsky Kyiv Polytechnic Institute (KPI) is determined by several factors:

1. Professional necessity: Understanding higher mathematics is critically important for a successful career in engineering and instrumentation. Students realize that this discipline serves as the foundation for many technical subjects and research. Higher mathematics is a fundamental component of engineering education, particularly in the field of instrumentation. Knowledge of mathematical methods is crucial for the development, analysis, and optimization of instruments.

2. Development of analytical skills, pursuit of knowledge: Studying mathematics fosters the development of logical thinking, the ability to analyze and solve complex problems, which are essential skills for engineers. Some students possess an intrinsic motivation for learning and acquiring new knowledge. They are interested in solving complex mathematical problems, developing analytical thinking, and engaging in scientific research and innovative activities, where mathematics plays a key role.

3. Career prospects: A high level of mathematical training opens up broader career opportunities, allowing individuals to work in various engineering and scientific fields. Understanding mathematics can open doors to prestigious job positions and opportunities for career advancement, serving as an important motivator in challenging times.

4. Personal interest: Some students have a natural interest in mathematics and strive to deepen their knowledge in this area. For some students, studying higher mathematics may be part of their personal goals and ambitions, such as participating in international competitions or pursuing postgraduate studies.

5. Curriculum requirements: Higher mathematics is a mandatory part of the curriculum, and students must study it to successfully complete their education.

6. Support from instructors: Instructors who have adapted their teaching methods to a remote format can create engaging and interactive lessons that encourage students to actively learn the material.

7. Academic achievements: The desire to achieve high grades and succeed in studies can be an additional incentive for students.

8. Support from peers: Interaction with classmates and participation in joint projects can enhance motivation through a sense of community and support.

These factors can interact with each other, creating a complex motivational picture for each student.

Thus, the educational motivation of instrumentation students (FIE) is a multifaceted phenomenon that depends on many factors, including interest in the profession, practical application of knowledge, professional prospects, and support from instructors. Effective methods of enhancing motivation include interactive teaching methods, involvement in research activities, individualized educational paths, and encouragement of achievements. Educational institutions aiming to ensure high-quality training of specialists should actively implement these methods into the educational process.

This will contribute not only to increasing students' motivation but also to their professional development and successful careers in the field of instrumentation. Ultimately, creating a favorable learning environment where students feel supported and have the opportunity to realize their potential is key to forming competent and motivated professionals.

Professional motivation of students for future professional activities is a combination of internal and external stimuli that encourage students to actively acquire the knowledge, skills, and abilities necessary for successful self-realization in their chosen profession. This type of motivation includes interest in the profession, awareness of its significance, the desire for self-realization, as well as the presence of clear professional goals and future plans.

Professional motivation is a key factor influencing students' academic activities, their activity, perseverance in learning, and readiness to overcome difficulties on the path to professional development. The professional motivation of engineering students is an important aspect that determines their future in the professional field. In Ukraine, given the current challenges and opportunities, this motivation acquires special significance. Let us consider the key factors influencing the professional motivation of engineering students and their readiness for future activities.

– Economic prospects and stability: One of the main motivators for students is the economic prospects offered by the engineering profession. A high level of salary, career growth opportunities, and employment stability make engineering specialties attractive. In the context of the Ukrainian economy, where some industries face instability, engineering professions often provide more reliable prospects.

– Innovative development and technological achievements: The modern world is rapidly changing due to technological innovations. Students who choose engineering specialties are usually interested in contributing to these changes. The opportunity to be part of innovative processes, work with the latest technologies, and create something new are powerful motivators.

– Educational opportunities and quality of education: The quality of education students receive directly affects their motivation. In Ukraine, many universities offer quality engineering programs that meet international standards. The presence of modern laboratories, access to international exchange programs, and collaboration with leading companies create conditions for high professional motivation.

– Social recognition and prestige of the profession: Engineering specialties traditionally enjoy a high level of social recognition. Participation in solving important societal problems, such as energy security, environmental sustainability, and infrastructure development, grants engineers prestige and respect in society.

– Personal development and self-realization: Many students choose engineering specialties due to the opportunity for personal development and self-realization. Engineering requires analytical thinking, creativity, and the ability to solve complex problems. This contributes to the development of personal qualities that are valued not only in the professional sphere but also in everyday life.

– Global opportunities and mobility: Engineering specialties open doors to an international career. Ukrainian engineers have the opportunity to work in different countries, participating in global projects. This encourages students to learn foreign languages and develop intercultural competencies, which also enhances their motivation.

In conclusion, the professional motivation of engineering students in Ukraine is shaped by a complex of factors, including economic prospects, innovative development, quality of education, social recognition, opportunities for self-realization, and global mobility. These factors interact with each other, creating an environment in which students can develop their skills, knowledge, and aspirations for success in future professional activities. Given the current challenges, such as rapid technological progress and globalization, it is important to ensure the support and development of these motivators to promote the preparation of highly qualified specialists who can work effectively both nationally and internationally.

STEM education, encompassing science, technology, engineering, and mathematics, plays a crucial role in enhancing the educational and professional motivation of engineering students in technical universities. Here are several aspects illustrating this role:

1. Integration of Theory and Practice: one of the key principles of STEM education is the integration of theoretical knowledge with practical skills. For instrumentation students, this means the opportunity to apply theoretical knowledge in practice, which increases their interest and motivation. In the context of distance learning, this can be implemented through virtual laboratories, simulations, and project activities, allowing students to work on real tasks and projects. STEM education encourages the integration of theoretical knowledge with practical skills. This helps students see the real application of what they learn, increasing their interest and motivation to study.

2. Innovative Thinking: STEM programs typically include projects that foster critical thinking and an innovative approach to problem-solving. This stimulates students' creativity and independent problem-solving, which is important for their professional careers.

3. Interdisciplinary Approach: STEM education often includes interdisciplinary courses that allow students to gain knowledge from various fields. This broadens their worldview and helps them understand how different disciplines are interconnected. STEM education involves an interdisciplinary approach, enabling students to see the connection between different scientific disciplines. For instrumentation students, this is particularly important as their professional activities often require knowledge from various fields. The use of interdisciplinary projects in distance learning can stimulate students' interest in learning as they see the practical application of their knowledge.

4. Career Preparation: STEM education is focused on preparing students for real working conditions. It provides skills that are highly valued in the labor market, such as programming, data analysis, and engineering design.

5. Active Learning: active learning is another important principle of STEM education. It involves engaging students in the learning process through discussions, debates, group projects, and other interactive methods. In a distance

format, this can be implemented through online platforms that support interactivity and collaboration. Such methods promote the development of critical thinking and problem-solving skills, which are key for instrumentation students.

6. Personalized Learning: STEM education also emphasizes personalized learning, which takes into account the individual characteristics and needs of each student. Distance learning provides the opportunity to create individual learning paths, allowing students to learn at their own pace and according to their interests. This can increase students' motivation as they feel their individual needs are considered.

7. Motivation through Achievements: through participation in competitions, projects, and research initiatives, students can gain recognition and rewards, which further motivates them for continued learning and professional development.

8. Support for Interest in Science and Technology: STEM education stimulates interest in science and technology, which can increase students' motivation to choose careers in these fields. The application of modern technologies is an integral part of STEM education. For instrumentation students, this means the opportunity to work with the latest tools and software. In the context of distance learning, this can be implemented through the use of online resources, distance learning platforms, and specialized programs for modeling and simulations.

Thus, STEM education is an important tool for enhancing students' educational and professional motivation as it not only provides the necessary knowledge and skills but also inspires professional development and innovation.

Conclusions. In the context of distance learning, the principles of STEM education can significantly enhance the motivation of instrumentation students by providing them with the opportunity to acquire current knowledge and skills necessary for successful professional activity. In conditions of rapid technological progress, education must meet new challenges, providing students with the necessary knowledge and skills. This is especially true for students of technical specialties, who must be prepared to work with the latest technologies. The integration of theory and practice, interdisciplinary approach, active and personalized learning, and the use of modern technologies create a favorable environment for the development of students. Implementing these principles in distance learning not only enhances educational and professional motivation but also ensures a deeper understanding of the material, prepares students for real challenges in their professional activities, and contributes to their overall development as competent specialists.

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Суліма О. В. Принципи STEM-освіти у контексті підвищення мотивації студентів-прибористів технічного університету в умовах дистанційного навчання

У статті авторка досліджує актуальні проблеми підготовки студентів у технічному університеті, зокрема на приладобудівному факультеті, в умовах дистанційного навчання. У сучасному світі, де технології стрімко розвиваються, освіта повинна відповідати новим викликам, забезпечуючи студентів необхідними навичками та знаннями. Особливо це стосується студентів-прибористів, які повинні бути готовими до роботи з новітніми технологіями. Одним із підходів, що може суттєво підвищити ефективність навчання, є STEM-освіта. Основні принципи STEM-освіти, розглянуті в статті, включають інтеграцію дисциплін, проблемно-орієнтоване навчання, практичне застосування знань, розвиток навичок 21-го століття, інноваційність та креативність, індивідуальний підхід до навчання, а також співпрацю та командну роботу. Ці принципи роблять STEM-освіту ефективним інструментом для підготовки студентів до майбутнього, де технології та наука відіграватимуть ключову роль.

Авторка аналізує фактори, що впливають на мотивацію. Вона також пропонує методи підвищення мотивації, включаючи інтерактивні методи навчання, залучення до науково-дослідної діяльності, індивідуальні освітні траєкторії та заохочення досягнень. У статті подано результати опитування студентів Київського політехнічного інституту імені Ігоря Сікорського, яке допомогло виявити чинники, що впливають на мотивацію до вивчення вищої математики, та методи її підвищення. Висновки дослідження підкреслюють важливість професійної мотивації, яка включає економічні перспективи, інноваційний розвиток, якість освіти, соціальне визнання, можливості для самореалізації та глобальну мобільність. Отже, впровадження принципів STEM-освіти в дистанційне навчання може суттєво підвищити мотивацію студентів-прибористів до отримання знань та навичок, необхідних для успішної професійної діяльності.

Ключові слова: *мотивація, студенти-прибористи, STEM-освіта, вища математика, інноваційне мислення, професійні перспективи, дистанційне навчання, міждисциплінарний підхід.*