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FORMATION OF TECHNOLOGICAL COMPETENCE OF FUTURE ENGINEERS IN THE STUDY OF GENERAL PHYSICS COURSE

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Abstract. *The article discusses the key aspects that make it possible to determine the category of "technological competence". A structural and functional model of formation and development of future engineers through forms, means and methods of teaching physics in higher technical educational institutionare proposed. The criteria and indicators for determining the level of formation of technological competence are proposed.*

Keywords: future engineer; general physics course; technological competence.

1. Introduction

"Post-industrial society" is a term that is widely used in scientific and everyday vocabulary, and the essence of which is not currently adequately defined and symbolizes the transition to the era, the center and the contents of which is an individual, capable for sustainable self-actualization in creative activities, of creating an appropriate environment and culture.

The currently observed revolution in the post-industrial society is the synthesis, a kind of «fusion» of radical changes in science, engineering and technology.

Technology and the means of production are continuously updating that makes demands of development the ability for systematic training techniques, operations, procedures and processes related to the implementation of the future pro-profession in modern engineer.

Thus, the category of «technological competence» can be considered as a part of general professional competence of future engineer, which reflects the ability and willingness to solve problems of professional activity using different technologies.

Changes in the socio-cultural sphere of society explain the processes aimed at the improvement of the modern education system.

The study points to the fact that the current diversity of approaches in education has one common base (postulate): a person's ability to meet their own needs and the needs associated with the processes of thinking are actively developing in real life.

The defining feature of modern technical higher education is a competence orientation that is the orientation for future engineers on experience of solving professional tasks studying at the university.

The study of "Physics" has a fundamental importance for the formation of both professionally-relevant competences of specialist of technical and technological profile and his scientific outlook, development of his creativity, competence in methods of scientific knowledge, promotes the comprehensive development of individual [2].

The theoretical and experimental methods used in teaching of physics in some way reflect the methods of physics as a science. They are a generalization of the global experience of teachers as they reflected all the ways of knowledge, critical thinking and technology: induction and deduction, abstraction and generalization, analysis and synthesis, the method of analogies, simulation.

The study of this discipline in higher educational institution, which is based on the fundamental principles of didactics (unity of educational, developmental and educational functions; scientific content and teaching methods; regularity and consistency; awareness and activity; communication training and practice; individualization; accessibility; visibility and strength of knowledge [4] and the use of modern informatization forms, means and methods of education develops a number of personal characteristics of a future engineer which can be correlated with the concept of "technological competence".

The basis of the actuality of the problem formation of technological competence of future engineers arethe internal and external contradictions.

The main contradiction is between:

– society's need in a new integrative quality of an engineer, which reflects the ability to navigate in the rapidly changing world of technology associated with the solution of professional problems, and insufficient development of the conception of formation of technological competence as a result of education;

– natural emergence of new engineering features associated in particular with the development of technologies and a significantly weak response of the content of university education in engineering;

– need in the formation of technological competence as soon as possible and rather weak saturation of the educational process of technical resources of the University (educational, scientific, industrial, cultural).

Thus, the clarificationof the conditions of the educational process of the course of general physics that contribute to the formation of the technological competence of engineers is the author's investigated problem.

2. Analysis of recent research

It should be noted that the structure and conditions of formation of the category «technological competence», which is a part of the general professional competence of the future engineer is not enough investigated.

Let's consider the semantic and content definition of the terms "competence" and "technology".

Analysis of publications indicates that the study of the terms "competence" and "competence approach in studying" is quite popular in modern pedagogical science.

Firstly, it is due to a global transition from a traditional subject-oriented to humanistic, student-oriented paradigm in education.

The basis of this phenomenon is the uncertainty and diversity of relations of the modern world.

The successful orientation in it certainly requires a non-standard thinking, the ability to debate, the rejection oflearning mechanically and memorization.

The modern life requires a person (from an engineer especially), firstly, deep professional knowledge, and secondly, the readiness for repeated changes in his activity.

The distinctive features of the modern professional are the ability to self-learning, lifelong learning.

Thus, the content of the modern paradigm of education can be stated as following: education is a creative work.

The term "competence" is largely the result of education and consists of a set of motivationally-valuable and cognitive components [16].

Here are some examples of the determination of "competence".

For example, it is a system unity that integrates personal, substantive and instrumental features and tools; "it does not just possess of knowledge, and the constant desire to upgrade them and use in specific circumstances" [3]; "the readinessof a specialist to be involved in a certain activity"; "ability to act in uncertainty" [9]; intellectually and personally experience caused by social and professional experience of human [16]; "a set of personal qualities ... (valuable and semantic orientations, knowledge, skills, abilities) that caused by his experience in a certain social and personal meaningful sphere" [6]; "Be competent means to know when and how to act. Competence is the ability to receive a scheduled concrete result" [15].

Modern research of the concept of «competence» is currently focused on the analysis of the four major aspects of this category:

– individual psychological characteristics, qualities and properties;

– the result of the manifestation of knowledge, skills and experience in the social sphere in the form of "key competencies";

– the result of activity, including education;

– educational outcomes in general [13].

A competence is a quality of personality, who has a certain level of education that expressed in his readiness (ability) based on it fora successful (productive, efficient) activity taking into consideration of his social significance and risks that may be associated with it [14].

A technology in the wide modern understanding is a set of principles that form a kind of "technosphere" which is definedboththe achieved technology and different sociocultural factors and procedures.

A technology is usually treated as a system of procedures, techniques, methods, principles and rules used in the manufacture of any type of product in any area of industrial activity.

A key component of technology is a technological process: a sequence aimed at creating a set of object operations (manufacturing operations), each of which is based on any kind of natural processes (physical, chemical, biological, etc.) and human activity.

This term is also used for a scientific and academic discipline that forms the theoretical and methodological foundations for the development of specific technologies, and a special form of fundamental and applied scientific and technical knowledge, the transition from natural scientific research to technological development.

The technology that is based on technical and engineering knowledge is the motive force of the development of technology, a mandatory condition

for its proper functioning. The rapid development of high-tech, knowledge-based information technology, nanotechnology is now the defining feature of scientific and technical and technological progress (revolution) [5].

Nowadays the concept of technological determinism, which tends to correlate the category "technology" with the key concepts of philosophical reflection such as civilization, culture, progress, values and identification gained a significant development.

So, J. P. Grant believes that the word "technology" means not only "machines and tools, butthat conception about the world, which manages our perception of all existing things" [5].

The combination of professional tasks of the future engineer, in which can be found the category "technological competence" is numerous, that make difficult its clear interpretation.

So, now there is no monosemantic component of the concept.

Detection, identification and structuring of the components of this category that characterizes the model of future engineer is a highlyrelevant issue which makes a significant contribution to the implementation of competence, activity, system and other approaches in learning and reflects the requirements for a specialist in the field of engineering and technology in a post-industrial society.

N. N. Manko finds it necessary to supplement the structure of the professional competence of a new component that he calls the technological competence and formulated it as a functional system of creative and technical knowledge, skills and stereotypes of tools' activities of reality transformation [10].

Most researchers refer to the features of technological competence:

1) an extended knowledge of various technologies;

2) continuous updating of knowledge on this issue for the successful solving of professional tasks;

3) the presence of semantic and procedural components.

In the technological competence A. A. Kharchenko identifies the following characteristics [7]:

– integrative and creative nature; high efficiency results;

– focus education on the practical application;

– the correlation of person's value and content characteristics;

– the formation of motivationfor self-improvement; academic mobility.

V. P. Bespalko [1], O. I. Nikiforova [11], L. Z. Tarkhan [13] investigating the structure of thepedagogical system admit that technological competence as an integral component of vocational and personality structure is determined by the complex of cognitive, operationally-active, didactic and design and reflective and analytical skills which are indirected by the value and semantic attitudes and motives of professional activity with guaranteed results.

The issues related to the pedagogical conditions of formation of technological competence of students of technical university examined in the study of O. Yu. Pleskachova [12] and of classical university inthe publications of A. V. Koklevsky [8].

Analyzing of educational content and methods of learning identified five teaching methods that reflect the degree of developing learning function of education: explanatory and illustrative or informational and receptive; reproductive; problematic; partially search or heuristic and research [4].

In theory of didactics, which deals with development of methods for training and their classification, it is believed that of learning occurs at three levels: a meaningful perception and memorizing; the use of knowledge asin a modeled and in a similar situation, the creative application of knowledge [13].

3. The purpose of the article

Based on theoretical and methodological analysis of general professional skills and abilities it requires to show the components and structure of the category "technological competence" and on this basis to create a model of its formation through modern forms and methods of teaching physics using the student-centered approach intraining.

4. The methodical system of formation of technological competence in future engineers

At the heart of building a structural model of technological competence is the analysis of the components of education standards for higher education, which reflects the social order: the Educational and Qualification Characteristics and Educational and Vocational Programs for bachelors.

These regulations summarize the content, scope and level of education and training of specialist: reflected goals in higher education and of professional training, requirements for the competence and other socially important qualities and characteristics.

The content of production functions and related abilities forms the professional and activity setting, but value and content settings form social and personal component of the total professional competence (Fig. 1).

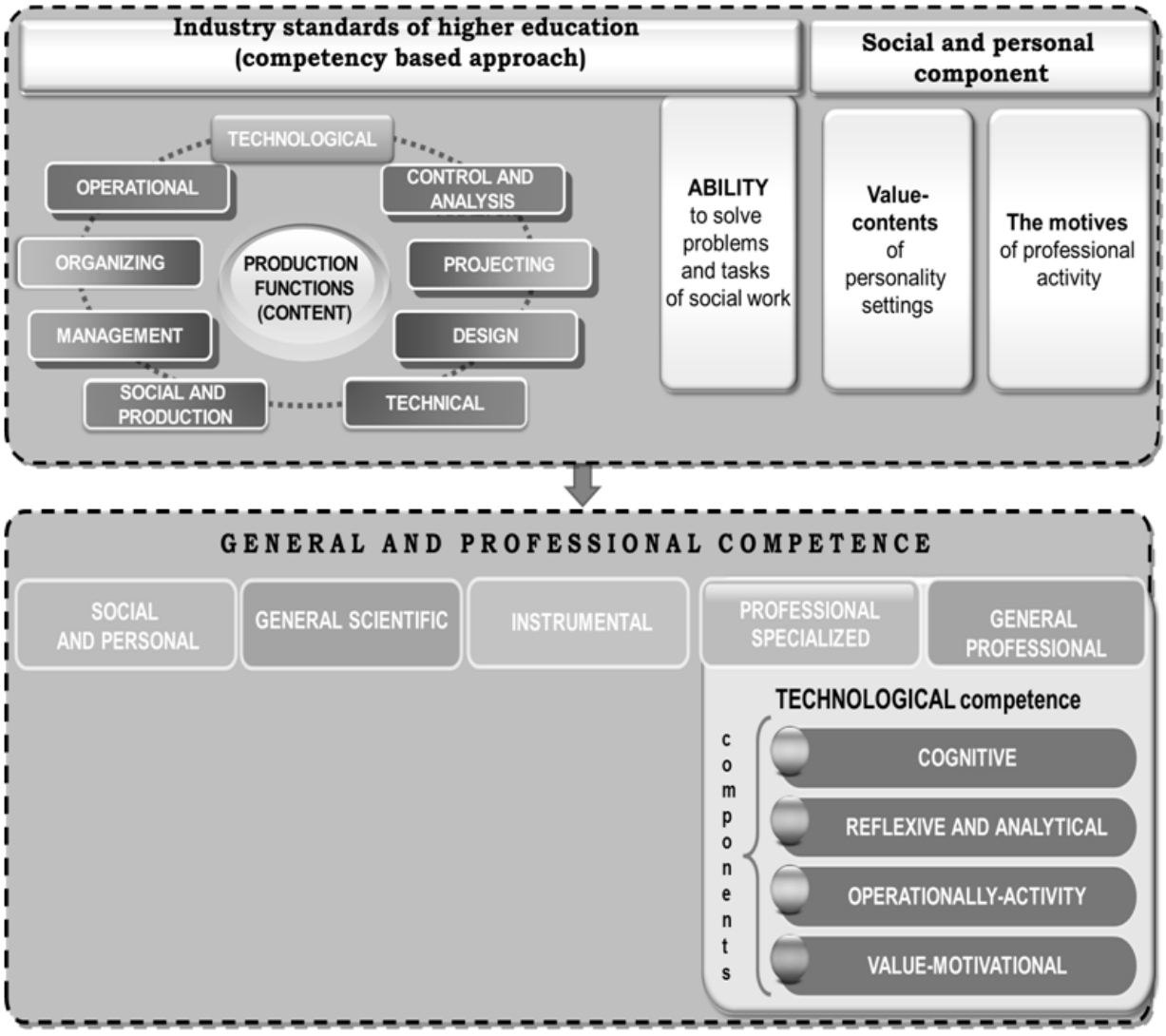

Fig. 1. Origin and components of technological competence of technical university graduates

There are the following competences as a part of the latter:

– research and development (characterizes the state of professional knowledge and the level of formation of professional skills and research skills);

– planning and design (characterizes by the ability to design, based on special design knowledge and skills, the use of modern technology and means of design, optimization and informed choice in the case of multiple solutions; accounting fast changing technologies);

– information that is associated with the processes of selection, learning, processing, transformation and generation of information in a particular type of subject-specific knowledge, which provide opportunity to develop, adopt, implement and predict optimal solutions;

– organization and management (characterizes the ability to create the conditions for professional activity, organization of work and team interaction, evaluation of expenditures of different origin, quality control of product, attestation and certification of systems, etc.);

– technological (characterizes the ability to use the basic laws and ways of transforming activities that are in accordance with the current and future state of society).

Technological competence, in our opinion, is composed of four following components:

– cognitive (characterizes a personality in terms of cognitive and creative activity, the ability to demonstrate technological knowledge, i.e. knowledge about the objects, means and ways of transforming activity);

– reflective and analytical (characterizes by the willingness to analyze his activities and evaluation of the achieved results, the ability to select of the most effective technologies, evaluate the degree of the technological risks, etc.);

– operational and activity (characterizes the level of skills and abilities of the choice of means, methods and technologies of design, modeling and planning of solution of professional tasks according to the specific goals and content of professional activity);

– value and motivational (is characterized by the level of development the ability for the steady inner motivation, which consists of purposeful activity, actions and behavior, attitudes to the surrounding reality, his chosen profession and work in general; such a system generates personality traits: the ability to self-education, professional activity on the basis of technologies that preserve life, self-development of creative abilities, readiness for performance of professional tasks).

On the basis of the fundamental "Physics" it was established the core of methodical system of formation of technological competence in future engineers (Fig. 2).

The target block scheme reflects the social order of society; the problem in content block reveals the structural components of technological competence, organizational and technological unit formed to meet modern and traditional approaches in teaching; education, educational, innovative and developmental functions of the proposed methodology system are in the functional unit; monitoring unit reflects a gradual control of the process and feedback from the organizational and technological unit.

Effective and criteria block is based on the use of cognitive, reflexive and analytical, operational and practical and personal criteria to determine the level of formation of technological competence of future engineers.

The best method is a survey of teachers and students. Indicators of formation of technological competence can be the following: adequacy of the applied methods, techniques, methods for the planned purposes; the optimal structure of activities for the planned results; the sufficiency of the selected content to implement activities that provide the planned result; adequacy the real, "visible" results to the aim; the level of predictive ability of the applied methods and tools.

Conventionally, there are three components of technological competence formation:– empirical and theoretical and reproductive (low) is characterized by a low level of systematization of knowledge and reflective and analytical skills, lack of sustained motivation and creative problem solving;

– algorithmic (middle) is characterized by the knowledge of the theory of technological processes, the ability to apply this knowledge in practice; expression of interest in technologies; the presence of skills of independent mastering method, technology and applying them in practice, the ability to distinguish causal connections, adequately assess the results;

– creative (high) is characterized by the ability to stable intrinsic motivation; the attitude toward a technological process as an effective recreating activity; willingness to the creative transformation of components or the development of a new technology; the ability to analyze internal and external links, build predictive schemes.

The formation of technological competence occurs in the organizational and pedagogical conditions that are characterized by a variety of criteria, including the criterion of feasibility, variability of modules, systems, reflectivity, adaptability, effectiveness.

5. Conclusions

The past studies make it possible to determine the category of technological competence of future engineers as their integrative quality, consisting of cognitive, operational and active, reflective and analytical and value- motivational components.

On the basis of them the modern specialist reveals the willingness and ability to knowledge and the use in a professional activity the laws and ways of creative engineering that match the modern state of technological processes effectively.

It determines his competitive position in the labor market.

The proposed model of technological competence by studying the subject "Physics" has a center-organizational and technological power, based on the forms, methods and modern technologies in didactics of physics.

The determining of the level of technological competence based on the criteria and appropriate indicators, which enable to differentiate low, medium and high levels.

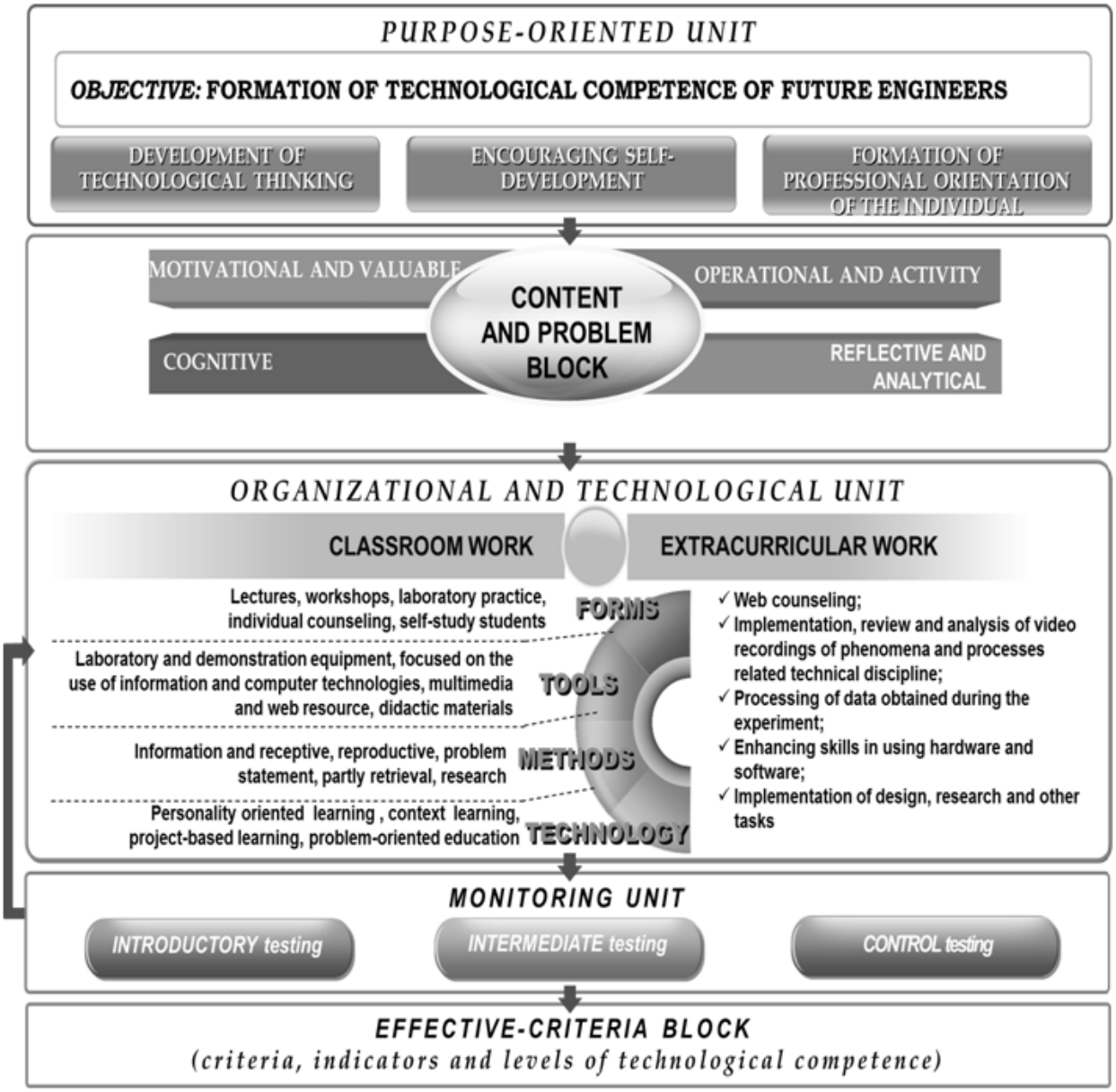

Fig. 2. Methodical system of formation of technological competency in future engineers

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І.А. Сліпухіна. Формування технологічної компетентності майбутніх інженерів у процесі вивчення курсу загальної фізики

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Розглянуто особливості конструкта «технологічна компетентність» – складової частини загальної професійної компетентності інженера. Проведено аналіз змісту і функцій компонентів даної категорії: когнітивної, операційно-діяльнісної, рефлексивно-аналітичної, ціннісно-мотиваційної. Визначено етапи формування технологічної компетентності з використанням форм, засобів, методів і технологій, характерних для дидактики дисципліни «фізика». Побудовано структурно-функціональну модель.

Ключові слова: курс загальної фізики; майбутній інженер; технологічна компетентність.

И.А. Слипухина. Формирование технологической компетентности будущих инженеров в процессе изучения курса общей физики

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Рассмотрены особенности конструкта «технологическая компетентность» – составной части общей профессиональной компетентности инженера. Проведен анализ содержания и функций компонент данной категории: когнитивной, операционно-деятельностной, рефлексивно-аналитической, ценностно-мотивационной. Определены этапы формирования технологической компетентности с использованием форм, средств, методов и технологий, характерных для дидактики дисциплины «физика». Построена структурно-функциональная модель.

Ключевые слова: будущий инженер; курс общей физики; технологическая компетентность.

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