PEDAGOGICAL PARADIGMS OF PROFESSIONAL TRAINING OF FUTURE ENGINEERS IN THE CONDITIONS OF EDUCATIONAL AND INFORMATION ENVIRONMENT OF TECHNICAL UNIVERSITY

INTRODUCTION

The state policy in the field of higher education is based on the principles of promoting the sustainable development of society by preparing competitive human capital and creating conditions for lifelong education. In this regard, there is a need to find new approaches to organize the educational process at a technical university.

Socioeconomic processes of education development put forward specific requirements for systematic, interdisciplinary human knowledge necessary for rational understanding of large amounts of scientific and technical information in order to solve new, non-standard problems, which is possible through the design of a training system.

The essence of designing a training system is revealed through clarifying the concept of “Paradigm”, which was first considered by the American scientist T. Kuhn (2001) in the 70s of the last century.

By introducing this term, the scientist meant that some well-established examples of the actual practice of scientific research, including law, theory, their practical application and necessary equipment, together give us models from which specific traditions of scientific research follow. Starting from this period, scientists began actively studying the issues of educational paradigms (table 1).
Table 1. Types of paradigms defined by scientists-pedagogues

| #  | Scientists                          | Paradigms                                                                 | Analysis                                                                 |
|----|------------------------------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 1  | Amonashvili S.O., 1995             | – authoritarian-imperative;                                               | The author tried to show that cognition and assimilation of knowledge should have a purely human character (cognition of oneself as a person, creating conditions for the coincidence of the interests of subjects of education with universal ones) |
|    |                                    | – humane                                                                  |                                                                         |
| 2  | Bulgakova N. B., 2009              | – pedagogical;                                                            | The scientist reveals the system of educational influences on the formation and development of personality during training |
|    |                                    | – andrological;                                                           |                                                                         |
|    |                                    | – acmeological;                                                           |                                                                         |
|    |                                    | – communicative                                                           |                                                                         |
| 3  | Galytyska A. P.                    | – conservative;                                                           | Directed a person to assimilate elements of culture, communication behavior |
|    |                                    | – cultural studies;                                                      |                                                                         |
|    |                                    | – culture creative                                                       |                                                                         |
| 4  | Kolesnikova I. A., 1995            | – pedagogical paradigms of traditions;                                    | The author used laws when a person is not able to comprehend the meaning and necessity of their own upbringing and development, and also reflects the importance of technology in universal values |
|    |                                    | – scientific and technocratic;                                            |                                                                         |
|    |                                    | – humanitarian                                                            |                                                                         |
| 5  | Kometov G. B., 2009                | – authoritarian;                                                          | The scientist formed the subject of education in such an environment, which is characterized by highly humane relations between a teacher and a student in the context of implementation of the idea of cooperation pedagogy |
|    |                                    | – manipulations;                                                          |                                                                         |
|    |                                    | – support                                                                |                                                                         |
| 6  | Luzik E. V., 2010                  | – intellectual and knowledge;                                             | The researcher proposed to change the value-semantic and activity-volitional structures of consciousness and assumed the unity of general cultural, value-oriented, socio-moral and professional development of the individual, as well as the education of mutual respect, kindness, communication culture, etc. |
|    |                                    | – creative and innovative;                                               |                                                                         |
|    |                                    | – value-oriented competencies                                             |                                                                         |
| 7  | Pinskyi A. A., 2001                | – traditionalist-conservative;                                            | The scientist tried to create optimal conditions for the realization of spiritual and intellectual capabilities of the individual |
|    |                                    | – rationalistic;                                                          |                                                                         |
|    |                                    | – phenomenological and humanistic                                         |                                                                         |
| 8  | Prikot O. G., 1998                 | – natural science;                                                       | The scientist considered the integrity of paradigms as the unity of the world and man. They are conditioned by a dialectical understanding of the surrounding reality and give an idea of the existence of connections between processes and phenomena in nature and social life |
|    |                                    | – technocratic;                                                           |                                                                         |
|    |                                    | – esoteric;                                                               |                                                                         |
|    |                                    | – humanistic;                                                            |                                                                         |
|    |                                    | – polyphonic                                                              |                                                                         |
| 9  | Rozov N. S., 2002                  | – liberal-rationalistic;                                                 | The author sought to master the legal, political, aesthetic, professional culture, vision of the prospects for the development of various branches of knowledge |
|    |                                    | – culturecentric;                                                        |                                                                         |
|    |                                    | – global historical                                                      |                                                                         |
| 10 | Thagapsoev H. G., 1999             | – conservative and educational;                                          | The scientist tried to create an environment for people to change their thinking and focus on cooperation, complicity, and compassion |
|    |                                    | – liberal-rationalistic;                                                 |                                                                         |
|    |                                    | – humanistic and phenomenological                                         |                                                                         |
| 11 | McDonald J., Stevens P., 1998      | – behavioristic                                                          | Scientists emphasize that in this approach there is a branching of the views of its supporters. There is a general approach that connects individual author’s positions into a single whole |
| 12 | Combs A., Blume R., Newman A., Wass H., Fuller F., Glassberg S., Sprinthall N., 1974 | – personal (includes: humanistic, individual, psychological)            | Scientists note that in education, the paradigm is expressed through the categories of subject, freedom, self-development, integrity, dialogue as a form of personality manifestation |
| 13 | Lanier J., Little J., S. Feimen-Nemser, Floden R., 1986 | – traditionally-creative                                                | Scientists note that knowledge is accumulated through practical activities |
The list of paradigms given in Table 1 and their scientific analysis allows us to conclude that the paradigm (from the Greek - example, sample), as a set of fundamental views, system concepts and ideas that are inherent in a certain period of development of science, culture, civilization, which is appropriate for each direction of the education system, at different times of its existence. Educational changes taking place at the present stage of social development mark the transformation of paradigms, which is associated with the transition from industrial to post-industrial and Information society, which encourages drastic changes in the system of higher technical education, requires a reassessment of its customs, worldview stereotype, for example, the focus on creative, planetary thinking.

Therefore, there is a problem of finding new educational paradigms or combining existing ones in a single complex, the main principles of which are the professional training of competent specialists, creative individuals who are able to independently expand and deepen the existing knowledge base, able to make situational decisions based not only on the factors of professional activity, but also on universal values. Based on the research of scientists, we tried to define, analyze and form modern paradigms of the educational and information environment of a higher technical educational institution, which form a holistic, consistent, new space and the presence of a person in it.

**RESEARCH PROBLEM**

The basis of educational changes is the transition from productive to creative abilities of future engineers, understanding of education and training in the educational and information environment as a personality-oriented phenomenon, which is the basis of the following paradigms: personal-educational, scientific-technocratic, competence-oriented. Let’s take a closer look at them. Thus, in the conditions of the educational and informational environment, the personal and educational paradigm is aimed at mastering the ways of educational actions and self-development of future engineers in the process of its implementation (Fig. 1).

**Fig. 1.** General strategy of training future engineers in the educational and information environment of a technical university

![Diagram](source)
It is known that in order for the teacher to be able to optimally adjust the intensity of the educational process, predictive feedback is used, the essence of which is the teacher’s prediction of the results (strategy) of training or the development of a predictive model of the educational process, which is a necessity in the process of pedagogical design of educational activities. In such cases, working curricula for each department, discipline, etc. are adjusted.

On the graph, this is reflected by tangents to the curve of the generalized learning strategy. During this period, the coordinate system is transferred to the tangent point to the curve of the generalized training strategy, requiring the development of a new training strategy at this stage of professional training of future engineers. Considering the training strategy as a plan of pedagogical actions, which is ensured by the unity of organization and management of the educational process for the formation of the educational and information environment of the institution of higher technical education, the relevant recommendations, principles, components of pedagogical activity are determined. As a result, the projections on each axis of the generalized learning strategy allows to determine:

- how long it is necessary for a high-quality professional training of one future specialist (a study group);
- how much costs a high-quality professional training of one future engineer (a study group);
- how much money should be spent for the entire period of a high-quality professional training of one future engineer (a study group).

Certain projections of the generalized learning strategy on each axis form the future engineer’s personal learning trajectory and show the influence of the educational and information environment on the training; for the teacher - a quantitative characteristic of personal efforts to prepare each future engineer (a study group); for the management of a technical university - an estimate of the training of one future specialist (a study group). This is very important, since only a significant part of modern knowledge can be included in the curriculum based on the selection of the content of the educational discipline in accordance with the essence of strategic goals and objectives of education at different levels and stages of high-quality professional training.

The scientific and technocratic paradigm in education, which is based on the outstanding achievements of science and technology and is aimed at scientific and technological progress, considering the pedagogical system as a set of three components: fundamental, applied and material, its essence is in the development of new knowledge, allocating for this, the most important place to the analytical abilities of the future engineer, that is, the ability to search and find the necessary information, accurately formulate problems and hypotheses, recognize certain patterns in data sets, find solutions in complex interdisciplinary tasks.

It is known that when training future engineers in an educational and informational environment, training methods can be different - from purely reproductive to interactive, but the essence of the idea of using a particular method remains the same: find an algorithm of actions that will allow to reproduce (show) the level of professional training with the greatest accuracy to ensure a complete reflection of future activities. Therefore, an important parameter of knowledge assimilation is the intensity of information assimilation (at a fast or slow pace). If this parameter is not considered, then, with a rapid pace of information assimilation, the future engineer will not have time to master knowledge, and with a slow one, interest will disappear, that is, the activation of cognitive activity decreases. Mathematically this can be reflected using the first derivative of the volume of information assimilation \( i_b(t) \), exactly, the intensity of knowledge acquisition \( \alpha_b(t) \), which is equal to:

\[
\frac{d}{dt}i_b(t) = \frac{i_b(t + dt) - i_b(t)}{dt} = \frac{di_b(t)}{dt},
\]  

where, \( i_b(t) \) - the amount of knowledge acquisition in the allotted time;
t - allotted time;
dt - a short period of time.

In this case, the parameter, intensity of knowledge acquisition \( \alpha_b(t) \), allows you to make a timely decision (choice, action) characteristic of any activity, which gives it purposefulness, and the ability of the teacher to make the right choice is determined by life experience (trial, error, etc.) and pedagogical teaching methods.

It is known that the freedom of independent decision-making, as a rule, is limited by certain rules of behavior and relationships in working teams within the accepted attitudes, standards and regulations, etc., which often put a person in strict conditions for getting out of problematic and conflict situations. On the other hand, it is natural that the layer of public consciousness that obeys the rules of technocratic existence resists knowledge and ways of behavior, refutes and calls into question these rules.

As we can see, the gradual implementation of certain pedagogical paradigms corresponds to the mechanisms of professional development of the individual. At the same time, we believe that the need for modern specialists who are able to creatively apply the acquired competencies, and solve professional situations outside the box, requires such training of competitive specialists, which can only be provided by a competence-oriented paradigm. Of course, it solves the problem of balancing certain pedagogical paradigms in the process of high-quality professional training of future engineers in the educational and information environment, since the competence-oriented paradigm:

- provides formation of psychological and professional-personal competencies (skills, qualifications, etc.);
- has a theoretical and methodological basis, which focuses on the assimilation of certain values and attitudes, which allows not only to build a holistic strategy for the development of education in order to create a single educational space, but also to ensure the purposeful personal and professional development of competitive engineers;
- defines the way to implement the competence-oriented paradigm in the process of high-quality professional training of engineers and can exist as a technology for personal growth and professional development.

That is why the result of professional training of future engineers is determined not so much by the set of competencies that they should acquire during training, but by the ways and technologies of mastering and managing the process of acquiring a certain system of key and special competencies. In the context of harmonization of existing pedagogical paradigms, the competence-oriented paradigm traces the regularity of acquiring certain types of competencies at different stages of professional development of a specialist. The central place in this process is given to the future engineer, who acts as an active subject of educational activity. When a future engineer is an initiative subject of future professional activity and has his own attitude to training, then he also forms his own style of mastering knowledge. So the next important parameter of knowledge formation in the educational and information environment is the acceleration of the volume of knowledge assimilation and change of intensity of knowledge acquisition

\[
i'_b(t) = \alpha'_b(t + dt) - \alpha_b(t) \over dt,
\]

where, \( \alpha'_b(t) \) - first derivative of intensity of knowledge acquisition;
\( \alpha_b(t) \) - intensity of knowledge acquisition in the allotted time;
\( t \) - allotted time;
\( dt \) - a short period of time.
Formula (2) confirms that the competence-oriented paradigm allows to determine the parameter of knowledge acquisition, which will adjust educational activities in accordance with the accelerated assimilation of knowledge, that is, the creation of an open didactic system as a set of internally agreed statements based on the unity of goals, content and didactic principles concerning the ways and organization of work of the teacher and future engineers.

RESEARCH METHODS

The study included conducting a pedagogical experiment, which consisted of two stages: ascertaining and formative. The formative experiment was of a comparative nature: two pedagogical teaching systems were compared - developed and traditional. In order to compare these systems, experimental (EG1, EG2) and control (CG1, CG2) groups of future engineers were created, which were trained according to the designed and traditional didactic systems, respectively. At the beginning of the experiment, EG and CG were identical groups in both academic performance and attitude to future professional activities.

During the training, experimental groups taught subjects within the framework of our proposed developed training system. At the same time, the training programs in professional disciplines in the experimental groups were somewhat reoriented in time, provided that the total volume of theoretical and practical materials remained unchanged. In order to compare the effectiveness of the previously existing and developed training of future engineers in the educational and information environment, we constantly recorded the results of the experiment on the basis of intermediate knowledge sections, which determined the level and quality of mastering future engineers’ competencies, characterized changes in academic performance, attitude to the future profession, activation of cognitive activity of future engineers of experimental and control groups. The results obtained were carefully studied. Generalization of these levels of training in three subjects, namely, “Radio-Electronic Systems”, “Microcontroller systems”, “Electronic radio monitoring devices”, is recorded in Table. 2, which indicate that as a result of the introduction of an experimental methodology, the level of knowledge of future engineers and the development of abilities in the study of disciplines increases by about 33 %.

RESEARCH RESULTS

In our study, special attention was paid to future engineers of the first year of study of the “Master” degree at the National Aviation University, namely, the institute of aeronautics, departments of electronics, specialty 171 “Electronics”, specialization “Electronic systems”. To train future engineers in the educational and information environment, we took into account the level of cognitive capabilities of each future specialist. For this purpose, at the stage of ascertaining and control experiments, the initial level of readiness of each future engineer was determined using the example of three academic disciplines in Table. 2.

Table 2. Dynamics of formation of the level of knowledge of future specialists for control and experimental groups (%) (number of respondents n=62)

| Academic disciplines               | Ascertaining experiment | Formative experiment |
|-----------------------------------|-------------------------|----------------------|
|                                   | Control group (n=14)    | Experimental group (n=16) | Control group (n=15) | Experimental group (n=16) |
|                                   | Reproductive | Productive | Creative | Reproductive | Productive | Creative | Reproductive | Productive | Creative | Reproductive | Productive | Creative |
| Radio-electronic systems          | 42.0         | 34.9       | 23.1     | 42.1        | 30.7       | 27.2     | 42.3         | 35.1       | 22.6     | 8.9          | 34.3       | 56.8     |
| Microcontroller systems           | 40.9         | 35.4       | 23.7     | 35.8        | 38.5       | 25.7     | 41.2         | 35.2       | 23.6     | 7.1          | 31.8       | 61.1     |
| Electronic radio monitoring devices| 39.9         | 37.8       | 22.3     | 37.4        | 35.2       | 27.4     | 40.1         | 38.9       | 21.0     | 6.8          | 30.4       | 62.8     |
| Average value                     | 40.9         | 36.0       | 23.1     | 38.4        | 34.8       | 26.8     | 41.2         | 36.4       | 22.4     | 7.6          | 32.2       | 60.2     |

Source: Search data.
The results of the initial level of knowledge of future engineers allowed us to draw conclusions about the optimal selection of subject information not only for successful assimilation of educational material in academic disciplines: “Radio-Electronic Systems”, “Microcontroller systems”, “Electronic radio monitoring devices” (fig. 2), but also further improvement of mastering competencies. During the formative experiment, the teacher observed changes in the parameters of knowledge assimilation, made an intermediate analysis of the results of knowledge assimilation and adjusted the pedagogical experiment.

Figure 2. Dynamics of the formation of the level of competence of future engineers during the experiment for control and experimental groups

Source: Search data.

The further stage of the practical stage was the collection and registration (measurement, description, evaluation) of all the final indicators of the educational process – a formative experiment, as well as drawing conclusions from the data obtained in the experiment through logical operations: analysis, synthesis, induction, deduction, etc. The greatest attention at the generalizing stage was payed to the processing of primary data of pedagogical observations and measurements. Secondary data were also analyzed, evaluated and generalized to make it possible to establish a link between the effects carried out in the experiment and the results achieved.

CONCLUSIONS

Consistent training of future engineers in the experimental group has become a positive incentive and means of high-quality acquisition of educational material. With the proposed pedagogical paradigms, future engineers are effectively guided and motivated to understand the material taught and are more interested in learning. When we implemented the developed structure of classes in accordance with the proposed pedagogical paradigms, the educational process have considerably changed: future engineers from passive students have become active participants in the educational process. The educational and information environment
of a technical university is being improved as an open system that unfolds in accordance with the logic and patterns of learning, and also exists in an indissoluble relationship with the development of the pedagogical system of an institution of higher technical education, the modeling of which allows to increase the level of its organization, technological and technical equipment. The integrity of the training structure in the educational and information environment is ensured by the unity of pedagogical goals, which allowed:

1. To develop pedagogical paradigms for the system of training future engineers in the educational and information environment of a technical university to get the most complete picture of the place in the system of higher education institutions and solve the main tasks in teaching - understanding and using information to obtain personal competencies.

2. Propose and apply pedagogical paradigms in the educational process, namely: personal-educational, scientific-technocratic, competence-oriented. Understanding educational paradigms from the point of view of a system of values that are focused on the complete formation of a personality. This is due to the need in modern society of developed, proactive, creative specialists who are capable of continuous improvement of their personality and professional activity. So, in order to systematize the professional knowledge in the educational process of a technical university in the conditions of an educational and information environment, it is necessary to consider certain pedagogical paradigms in relation to each other.

3. To investigate the use of pedagogical paradigms for training future engineers in the educational and information environment. The effectiveness of the application of the pedagogical training system in the educational and information environment is achieved when the relevant teaching technologies are reasonably and harmoniously integrated into the educational process, enriching pedagogical technologies, facilitating the implementation of training tasks, and the experience, knowledge, traditions accumulated in the education system, replenish the content, general cultural component of the educational and information environment - from the scientific and methodological laboratory of a separate institution of higher education to the global internet.

Thus, modern educational paradigms are determined by the influence of the phenomenon of human development in the XXI century - globalization, which covers not only the current political, economic and social state of the world community, but also actively enters the European and world educational space of the third millennium. The peculiarity of this phenomenon is the rapid development of information technologies, a wide field of socio-economic integration processes between states, which determines the conceptualization and materialization of scientific ideas concerning the education system as a whole. Understanding educational paradigms from the point of view of a system of values that are focused on the formation of a person, is due to the need for modern society of developed, proactive, creative specialists who are capable of continuous improvement of their personality and professional activities. So, in order to systematize the professional knowledge in the educational process of a technical university in the conditions of an educational and information environment, it is necessary to consider certain pedagogical paradigms in relation to each other. The pedagogical paradigms of professional training of future engineers in the educational and information environment of a technical university enable determining the content of academic disciplines. In the future, it is planned to consider the specifics of formation of the educational and information environment in higher technical educational institutions based on the applied actions of the considered pedagogical paradigms.

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Pedagogical paradigms of professional training of future engineers in the conditions of educational and information environment of technical university

Paradigmas pedagógicos da formação profissional de futuros engenheiros nas condições de educação e ambiente de informação da universidade técnica

Paradigmas pedagógicos de la formación profesional de los futuros ingenieros en las condiciones del entorno educativo y de información de la universidad técnica

Resumo
O artigo identifica e analisa o paradigma da formação do ambiente de informação educacional nas instituições técnicas de ensino superior. Os autores apresentaram o paradigma baseado na humanitarização do ensino superior, que visa fornecer orientação e motivação valiosas para estabelecer critérios para a criação de condições de auto-desenvolvimento e realização pessoal de futuros engenheiros. O artigo argumenta que a revelação da integridade da educação e da regulação da inovação científica, pesquisa e prática das atividades de formação e paradigma educacional deve ser considerada em conjunto. Os paradigmas pedagógicos da formação profissional de futuros engenheiros no ambiente educacional e de informação de uma universidade técnica permitem determinar o conteúdo das disciplinas acadêmicas. Em geral, a análise da dinâmica de formação e desenvolvimento do paradigma ajuda a preservar os princípios da aprendizagem e de um núcleo genético da ciência e da prática pedagógica nacional.

Abstract
The article identifies and analyzes the paradigm of educational information environment formation in the technical higher educational institutions. The authors presented the paradigm based on the humanitarization of higher education, which aims to provide valuable guidance and motivation to establish criteria for creating conditions for self-development and personal fulfillment of future engineers. The article argues that revealing of the integrity of education and regulating scientific, research and practical innovation of training activities and educational paradigm should be considered in conjunction. The pedagogical paradigms of professional training of future engineers in the educational and information environment of a technical university enable determining the content of academic disciplines. In general, the analysis of the dynamics of formation and development of the paradigm helps to preserve the principles of learning and a genetic nucleus of the national pedagogical science and practice.

Resumen
El artículo identifica y analiza el paradigma de la formación del entorno de información educativa en las instituciones de educación superior técnica. Los autores presentaron el paradigma basado en la humanitarización de la educación superior, que tiene como objetivo proporcionar una valiosa orientación y motivación para establecer criterios para crear condiciones para el autodesarrollo y la realización personal de los futuros ingenieros. El artículo argumenta que la revelación de la integridad de la educación y la regulación de la innovación científica, de investigación y práctica de las actividades de capacitación y el paradigma educativo deben considerarse en conjunto. Los paradigmas pedagógicos de la formación profesional de los futuros ingenieros en el entorno educativo y de información de una universidad técnica permiten determinar el contenido de las disciplinas académicas. En general, el análisis de las dinámicas de formación y desarrollo del paradigma ayuda a preservar los principios del aprendizaje y un núcleo genético de la ciencia y la práctica pedagógica nacional.

Keywords: Educational information space. Educational information environment. Pedagogical paradigm. The quality of vocational training.

Palavras-chave: Espaço de informação educacional. Ambiente de informação educacional. Paradigma pedagógico. A qualidade da formação profissional.

Palabras-clave: Espacio de información educativa. Entorno de información educativa. Paradigma pedagógico. La calidad de la formación profesional.