CURRENT SYSTEMIC INNOVATION OF UNIVERSITY EDUCATION

Nikulin O. Candidate of Technical Sciences, Associate Professor of the Department the Metallurgy and Metal Forming, Dniprovsk State Technical University, Ukraine

Nakonechnay T. Candidate of Physical-Mathematical Sciences, Associate Professor of the Applied Mathematic Department Oles Honchar Dneprovsky National University, Ukraine

Summary. In order to carry out the transition of the economy the Ukraine to the sixth technological order, neo-industrialization must be carried out, which also requires significantly accelerating the processes of reforming higher education, training and retraining of specialists. The purpose of the work is to detail the systematic use of innovations in the training of submitters at technical universities. The conceptual and methodological significance of synergistic ideas for improving the activities of universities is related to the ability of educational systems to self-develop not only due to information and material flows from the outside, but also due to the use of their internal capabilities. The application of a systematic approach using graphic modeling, including casual, in the analysis and synthesis of solutions to emerging tasks, contributes to the improvement of the processes of training submitters and preparation and defense of qualification works.

Keywords: neo-industrialization, innovation, educology, graphic modeling

Introduction. The problems of the transition the world economy to the sixth technological order are gaining importance in the innovative society of the first half the 21st century with the vector of movement determined by the "race for novelty" and the corresponding forms of socio-economic relations. In current conditions of the world market, the use of creative achievements and innovative technologies allows to win in competitive relations [1]. At this stage, neo-industrialization is relevant for the economy of Ukraine, which relies on the efficiency of the processing industry (PI) [2]. It is proposed "... to understand the neo-industrialization of PI as a model of innovative development the processing enterprises based on high-tech, resource-saving and knowledge-intensive technical processes, which organically combines in its structure traditional and modern types of activity, acting as a basis for the formation of a progressive model the social production harmonized in terms of quantitative, qualitative and social ecological parameters with the requirements of personal and social elevation" [3].

The effective development of enterprises and organizations, as well as the functioning of educational institutions that ensure the fulfillment of their orders,
depend on the use of the scientific approaches and planning of activities taking into account the latest achievements. Significant shifts and transformations are taking place in applied sciences and their branch associations. As a result of their use, a dynamic system of technological, economic, and social relations is formed. An innovative basis is important for this system, and the competence of future personnel (to work in the system in a new way) needs to be formed in the training process [4].

When developing the modernization of education, it is advisable to move to the implementation of social innovations – the process of updating the spheres of life and activity during the reorganization of society (in education, management process organization systems, etc.). The concept of "innovation", introduced in the thirties of the 20th century in the works of J. Schumpeter, for the 21st century has turned into the main tool for ensuring not only the technical progress of society, but also its development in general. In the process of natural evolution, the form of a holistic innovation system was formed as a set of objects and subjects of innovative activity that interact in the process of creating and implementing innovative products. The innovation system has its own developed structure, the elements of which are innovators and infrastructure. Its toolkit is innovative activity - a cycle of work from the creation of a promising product, bringing it to the state of an innovative product with implementation on the market or in developing systems.

From the point of view the social innovations, the main task of a modern higher education institution is to provide students not only with the sum of knowledge and skills, but also with the formation of competencies that will enable them to actively and effectively respond to the dynamically changing socio-economic conditions in their further professional activities and to meet the needs of the individual and the labor market in the implementation of competence. Therefore, it is necessary to use the advantages of the scientific approach to solving the problem of increasing the efficiency of higher education of the first and second level.

Problem Formulation. The transition of Ukraine to the regime of neo-industrialization significantly accelerates the processes of reforming education. Transformational processes in the world led, first of all, to a change in paradigms in education at all levels. In the center of attention (according to all concepts, doctrines, laws on education) is a competent, spiritual, competitive personality [5]. The purpose of this work is to detail the use of innovation and educology in the training of submitters for technical specialties with the help of graphic modeling.

The directions [6] for the modernization of higher education in Ukraine include:
- improvement of the model of the multi-level system of higher education, which can be comparable to the European one;
- continuous updating of the content of education based on the latest achievements of culture, science, and technology in the form of a stable "core" in the form of a system of knowledge and technologies and a changing periphery;
- innovative changes in the technologies of the educational process (modular-rating, "block", "case", distance systems, increasing the importance of independent work, creating zones of "free development" personality and individual programs, etc.);
- development of the material and financial base of education.
An important problem of the education content is the choice of its basic model and raising the bar of final learning results. Methodists of all levels defend the content model - a complex of knowledge, abilities and skills that is modernized from time to time with the aim of forming set competencies and obtaining appropriate training results. Didactics, psychologists and philosophers consider a multidimensional model of the content of education: subject component, activity, motivational and spiritual. This corresponds to the new educational paradigms, concepts and doctrines. Therefore, "in the center of attention is the individual." In addition, in the process of acquiring a modern education, this individual must develop a non-linear type of thinking [7], which means a person's ability to adequately perceive and analyze, make decisions and achieve set goals in the complex non-linear of world, which is self-organizing.

Innovative technologies in the educational process of higher education cover its content, essential characteristics, the entire complex of didactic techniques that are used in pedagogy in general, in particular in university education. These include: permanent fundamental and applied scientific support for education with appropriate information technologies; introduction of research methodology and methods into lecture courses and independent work; the application of scientific research activities; transformation of student answers, essays in classes into a kind of defense the relevant conceptual provisions of normative and special courses; systematic combination of classroom and extracurricular classes into a single educational complex; directing the work of student scientific circles and other forms of scientific research work of submitters to search for and creatively assimilate innovative ideas of domestic and world science and practice; using the final annual scientific university, republican, international conferences and other forums for systematic analysis and evaluation of the work carried out for a certain period in view of its innovative contribution.

In general, the trends in the management of innovative processes operating in educational organizations indicate a refusal to apply the principles of authoritarian pedagogy and, on the contrary, their approval of the principles of democracy and decentralization; about carrying out business activities and obtaining various types of investments; activation of public and state efforts to reach the level of international standards and achievements; the desire of managers to master the technologies of professional educational management (including innovative ones), the competitiveness of educational institutions based on the expansion educational services.

Large-scale innovations include innovations that qualitatively change the purpose, the content, tasks and structure of education and, as a rule, are studied at the all-Ukrainian level; to local – those of them that qualitatively change the forms, methods and means of education and are tested at the regional level [6]. It should be noted that innovative processes in higher education contribute not only to a significant increase in the theoretical and practical training of students, but also to the methodological reorientation of educational institutions on the individual, becoming the basis of a change in the philosophy of education that meets the following basic requirements: taking into account the peculiarities of the educational process, its content and structure, life cycles of higher education submitters, their
abilities, interests and inclinations; towards the modeling of the educational environment, its organizational, methodological and content components, taking into account typical and individual differences between students of higher education, the forms of their manifestation in the sphere of communicative relations and in cognitive activities, the experience of interaction with the surrounding world; variability and personality-oriented orientation of the educational process, as a result of which students' knowledge, abilities and skills are transformed into a means of developing their cognitive and personal qualities, ensure their ability to be the subject of their own development, reflective attitude towards themselves; ensuring a holistic psychological and didactic design of the educational process in conditions of multi-level and profile differentiation of education.

Therefore, modern education "is in search of a new strategy of thinking, aimed at paradigmatic transformations in the system of knowledge about man, society, nature, the world as a whole" [8], and aimed at introducing innovations. The effectiveness of solving educational problems is related to the use of a systematic approach.

Results of modernization the university education by innovative basis. In the very nature of science lies the desire for synthesis and generalization of knowledge. Identifying and studying the specific content of this process is the task of modern research in the field of methodology the science. Most modern sciences are built on the system principle. The system approach is based on the fact that the selected object is considered as a set of interconnected elements (components), which has an input (resources), an output (related to the purpose of the system) and connections with the external environment and, as a rule, feedback. The implementation of this approach is a modern form of applying the theory of knowledge and methodology to the study of processes occurring in nature, technology, society, and thinking.

The object of scientific research in the field of education is the content, connections and relationships of elements, blocks and systems of various natures in the educational process, which have object and subject content. The object of research can be real (group of students, library funds, available software), as well as ideal (paradigm of education, ideal gas, point, etc.). Material objects of research are divided into natural ones that exist in nature and society, and artificial ones that are purposefully created.

Technical objects and processes stand out among artificial objects. The main feature of technical objects is their purposeful creation according to a certain image. The creation of a unified methodology of modern engineering activity is based on interconnected processes of research and design of technical objects. They are based on the use of a system approach, which makes it possible to consider the object of research and the object of design as a technical system, that performing specified functions in interaction with external environment.

Modern technological processes of forming metals by pressure are complex systems determined by a large number of parameters. Currently methods of system complex research are widely used to consider complex systems. Modern ideas and principles of designing and researching complex systems are based on a systemic approach. For a designer or specialist, they are obvious and natural, but their
observance and implementation are often associated with certain difficulties caused by the specifics of the situation. When solving complex problems, system analysis gained popularity. Practicing engineers use a systems approach without reference to systems analysis manuals. However, an intuitive approach without applying the rules of system analysis may prove to be insufficient for solving engineering tasks that are becoming more and more complicated. 

The main general principle of the system approach is to consider the parts of a phenomenon or a complex system, taking into account their interaction to achieve the aim of the system. System analysis includes identifying the structure of the system, typifying relationships, defining attributes, and analyzing the impact of the environment. Already at the design stage, it is assumed that the achievement of the system aim occurs in multi-step decision-making processes. Therefore, decision-making methods are often separated into a separate discipline called “Decision-making Theory”.

System analysis united a number of directions, such as system engineering, system project management, system design of organizations, etc. within the framework of which many complex system design problems were successfully solved [9].

Designers and technologists, who create new types of products, develop and improve various objects of equipment and technology, deal with so-called technical objects. There are many technical objects, and they are very diverse, but there is something common to all of them: any object consists of a collection of individual elements; elements can be not only of different shapes, but also have different physical and chemical properties; the elements are related to each other in a certain way. These general characteristics define any object as a system.

A scientific approach to the modernization of existing and the development of new training methods is an integral part of the further development of the education system. In the life of modern society, taking into account the achievements of high technologies and ICT, further development and systematic adjustment of the effectiveness the established educational methods are needed.

In connection with the growing complexity of the learning process, didactics as a section of pedagogy is no longer able to fully structure the process of general scientific and professional training of students. There was a need for an integral scientific discipline that implements a systematic approach to the development of training systems, oriented to the quality of the result of training submitters, which meets the requirements of the time. It seems appropriate to turn to educology.

The technological problem of improving the content of education consists in the need to establish a connection between the general declared aims of education, such as "multifaceted development of the personality", and the specific content of each educational course, discipline. That is, before allocating the hours of the educational program to academic disciplines, as well as before developing the program itself, it is necessary to compile a complete list of specific aims. What specifically should a graduate of the chosen field of knowledge and specialty know, what should he be able to do, what experience of creative activity should he acquire, what personality qualities and competence should he have formed - that is, conditionally speaking, it is necessary to draw up and use a "model personality development of the graduate".
Economic, scientific and technical transformations have a significant impact on the life and activities of representatives of modern society, they present new problems, the solution of which is impossible in the absence of engineering knowledge and technical thinking. Accordingly, increasing the effectiveness of scientific and technical education is conditioned by modern social challenges.

Under such conditions, the issue of improving the skills of teachers and activating the cognitive activity of students is acute. The use of modern pedagogical technologies helps in solving these issues. The use of graphic modeling is one of these technologies [10].

The educational graphic model (EGM) is considered as the result of sign-symbolic idealization, which has acquired a material graphic form and is designed to reproduce the object of study in the process of organizing the cognitive activity of learners. The models used in the work belong to the means of visualization, which, thanks to the activation of cognitive questions, should ensure active cognitive activity. The creation of a graphic educational model by the teacher in cooperation with students should provide them with the opportunity to acquire new knowledge about the original educational object.

In order to train future specialists to effectively apply EGM, it is necessary to teach them to understand the mechanism of action the structural and logical graphics. They should understand the specific features of EGM, namely:
- the graphic educational model is iconic;
- image and sign in the model not only do not exclude each other, but on the contrary - complement each other;
- the model has an operational function, as it indicates the method of organizing activities aimed at identifying the essential properties of the research object;
- the heuristic function of the model is to direct the acquirer to solving problematic questions and tasks.

In the process of graphic modeling, which involves the possibility of collapsing a significant amount of educational information and its visualization, innovative objects are created. At the same time, the educational material is compressed, structured and systematized with the active participation of students.

Considering the dynamic and multifaceted nature of the development the modern society, when solving innovative problems in education, it is necessary to go beyond the framework of traditional pedagogy and turn to educology, taking into account the content of sciences that represent the scientific foundations of the learning process (Fig. 1).

In accordance with the purpose of working with the content and aims of learning, we will consider in more detail the relationship between didactics, pedagogy and educology. Indeed, according to the modern encyclopedia of pedagogy:
- didactics examines the general regularities of human cognitive activity, which occurs both under the guidance of a teacher and independently, through self-education [11, p. 134];
- pedagogy is the science of the essence the development and formation of the human personality and the development on this basis the theory and methodology of education and training as a specially organized process [11, p. 424];
- Educology is the science of training, cultivation in the education system of a holistic creative personality that is aware of itself as a subject of activity in the surrounding world [11, p. 674].

The term "educology" literally means "science of education". Educology is a systematic science based on the results of developing sciences and technologies, but the origins of its emergence are connected with the evolution of human culture and education [12].

Currently, there is a situation of restructuring and qualitative changes in science, technology, and society, which pass through bifurcation points in their development. For example, higher education in Ukraine is in a state of transformation, which must be accompanied by innovations in didactics, educational and management processes, the effective implementation of which requires new educational approaches. Therefore, in most cases, there is a restructuring and complication of existing models relevant and oriented to their use in the organization of research and training.

When building a mathematical model of a fundamental or technical science [13], as well as a corresponding educational discipline, it is advisable to apply a functional-structural approach, considering the modeling object as a synergistic system (Fig. 2).
The corresponding system of MS (model of science) is considered as a set
(ordered collection) of a species

\[ MS = \{AP, BKD, SSS, FS, RE, AR, ISS, ESS\} \]

where

- **AP** – aims and problems,
- **BKD** – bases of knowledge and data,
- **SSS** – structure of science system,
- **ISS** – internal sources of system,
- **FS** – functions of system,
- **ESS** – external sources of system,
- **AR** – adaptability ratio
- **RE** – ratio of emergency

These subsets are, as a rule, multilattices and endowed with operations union,
section and composition. In addition, if necessary, they are introduced relations:
" = ", " ≠ ", " < ", " > ", mapping subsets into each other. Next, when creating a
synergistic system, a synthesis of the structure is carried out, this is adjusted
according to the functional purpose and the given criterion. Functionally, the
structural approach involves the implementation of the results of the analysis and
synthesis of a multi-level system, considering it in development. This approach
reflects the unity of general scientific and special knowledge as a system with
ensuring the unity of structure and functions with the determining value of functions.

Note that a large role in the self-organizing system is played by the properties
of the network used elements, which are subject to a number of multidirectional
requirements.

The network of elements must meet the requirements for indicators:
1) difficulties; 2) functional redundancy; 3) variability of the structure;
4) structural homogeneity; 5) parallelism; 6) multifunctionality;
7) hierarchies; 8) distributability.

Another, no less important problem of the formation the system of science
and education is the choice of the basic model the content of education. Here, on
the one hand, a semantic model is used, that is, a complex of knowledge, abilities
and skills that are constantly being modernized. On the other hand, a
multidimensional model of the content the education is used: subject component,
activity component, motivational and spiritual component (when "personality is in
the center of attention").

The modern change of the concept of collective learning to the concept of
personal learning tracks leads to significant changes in the methodology of the
educational process and in the restructuring of teaching and student contingent.

The increase in the multidisciplinarity of the departments makes it difficult to
conduct applied research within the departments, which leads to the need in
organize scientific teams and schools according to the laboratory principle outside
the subordination of the departments. This state of affairs promotes the progress of
systematic research, but changes the established management and organizational
processes.

Educolgy is dedicated to systematic research in the field of education, where
traditionally individual components are either studied by separate scientific
disciplines (pedagogy, psychology, and others) or are prescribed by order. Therefore,
the main principle of implementing the educological approach will be the principle
of mutuality, that is, the principle of studying relationships, relationships and mutual
influences between individual structural and functional components of the field.
In accordance with the above, the use of synergistic components of the system at the department level is updated. The main concepts of synergy are openness, non-linearity and imbalance. The theory of self-organization operates with such concepts as bifurcation points, fluctuations, dissipative structures, attractor and fractality. Their use in the organization of learning processes can be extended by implementation taking into account educational aspects (Table 1).

Table 1

| Basic concepts of synergy | Educological aspects |
|---------------------------|----------------------|
| Attractor                 | Relatively stable possible states to which the processes of evolution in open nonlinear systems reach; that is, we can say that the future state of the system "attracts, organizes, forms, changes" its current state |
| Bifurcation               | Alternative branches of the possibility tree. A critical moment of uncertainty in the future development of the system |
| Chaos                     | The emergence of situations of uncertainty, the lack of a single solution and approach, a problematic situation. Unorganized and spontaneous aspirations of the acquirer and destabilizing external influences |
| Eventuality               | Moving away from strict training programs, emphasizing the importance of improvisation, intuition, the ability to change the movement of the lesson scenario due to a seemingly "small" event |
| Fluctuation               | Quite small constant changes, oscillations and deviations. They create a state of instability, unevenness |
| Non-linearity             | Internal opportunities for qualitative transformation in education systems through the transition from the old order to the new |
| Self-organization         | This is a process or a set of processes occurring in the educational system, which contribute to the maintenance of its functioning, which contribute to the self-building, self-renewal and self-change of this education system |
| State of instability the nonlinear environment | Uncertainty and the possibility of choice, the ability to which should be considered an important quality of the system that passes through critical situations, which opens up the possibility of survival and existence |

Education can be considered the open system, because, firstly, in it, against the background of a purposeful movement to solve the tasks, there is a constant process of information exchange (based on circulating knowledge and data) between the teacher and students (direct and feedback). During this process, new aims, methods and means of the learning appear.

Secondly, the content of education changes as a result of social processes in society. It should correspond to the system of values, knowledge and skills achieved up to this point. There is a non-linearity of both the process and the result. The result of the educational process always differs from the initial ideas of its participants.

Thirdly, the constant increase in the educational information space and the latest technologies bring the system out of stable equilibrium.

As you know, synergetics is based on the principle of evolution the surrounding world according to non-linear laws. In a broad sense, this idea can be expressed in
the multivariate or alternative choice. In the education system, multivariate means creating the conditions of choice in the educational environment and giving each subject a chance of individual movement to success, stimulating the independence of choice and making a responsible decision, ensuring the development of an alternative and independent path.

More specifically, such a choice consists in the ability to determine the individual trajectory of education, the pace of learning, to achieve different levels of education, to choose the type of educational institutions, educational disciplines and teachers, forms and methods of learning, individual means and methods, creative tasks, etc.

The process of self-organization is an involuntary emergence the new structures as a result of fluctuations the relatively stable mode in open unbalanced systems. Self-organization in the educational system is based on the presence of regular and meaningful interaction between the teacher and those being train, which meets the requirements of the functioning the system and follows from the objective prerequisites of its self-movement. The formation of closely interacting groups of students and mentors is taking place. This allows us to understand the internal mechanisms of synergistic development of educational systems.

The conceptual and methodological importance of synergistic ideas is connected with the recognition of the ability educational systems for self-development not only due to material flows and information from the outside, but also due to the use of their internal capabilities.

As a basis of conceptual approaches to the training of higher education and scientific degree holders is the concept of four "letter I" proposed by Academician V.I. Skurykhin [14].

The essence of the concept is to give priority to four areas of development: intellectualization, that is, each next step should lead to smarter activity; informatization, primarily due to the spread of electronic information technologies; individualization, as the possibility of adaptation for each user; integration, as a process of combining disparate components into systems and complexes.

The training of students in Ukraine, which provides basic and full higher education to submitters, is complicated by an acute shortage of modern scientific and technical literature [15]. Of course, the use of information technologies and network resources alleviates the situation, but does not remove the urgency of improving training taking into account modern results of science and technology, development of methodology and methods of applied and fundamental sciences.

In order to determine the reasons that affect the effectiveness of the training the students, consider the relevant Ishikawa cause-and-effect diagram (Fig. 3).

According to the "six M" rule [16] (no more than six main possible cause-categories are taken into account in order to exclude excessive bulkiness of the model), casual categories determining the effectiveness of student's training are selected, namely: "Professorial staff", "Material-technical and educational-methodical support", "Unified information space of the university", "Submitter of higher education", "Management" and "Control" of the educational process. They are the most important factors affecting the solution of the problem of increasing the efficiency of student's training. Deepening the analysis leads to branching of the
Fig. 3. Ishikawa's diagram by problem of effectiveness the training students

diagram, this acquires a tree-like structure. In the decomposition, the factors determining the influences of the above reasons are noted (Fig. 4).

Fig. 4. Decomposition of Ishikawa diagram by effectiveness of training students
Having considered the category "Material-technical and educational-methodical support", we can conclude that, in turn, the most important is the link "Educational technologies", which include such important components as the organization of independent work and research work of future masters, interactive educational technologies and individualization of education.

In modern conditions, the implementation of educational technologies directly depends on the availability and functioning of information systems. The factor "Information systems" determines the nature of the activity of the entire university, as information technologies ensure the movement of educational digital resources from the university to the submitter of higher education, create a single information space of the educational institution, which makes the work of the university easier, more convenient, reduces the load factor on its various divisions and most often excludes errors due to the human factor.

The use of the Ishikawa diagram in the field of education allows you to establish positive and negative factors that affect the quality of higher education, identify their cause-and-effect relationship, and display this relationship in a visual form.

On the one hand, the diagram helps to identify factors affecting the quality of knowledge of higher education students. On the other hand, it can be used to model the desired level of quality of higher education and determine the characteristics affecting it.

Cause-and-effect (casual) modeling can be used in the organization of educational research, as well as in the performance of qualification works of applicants [17]. So, for example, the initial step of constructing the Ishikawa cause-and-effect diagram for the analysis of the problem "Longitudinal stability of rolling" [16] is presented in Fig. 5.

Further, in accordance with the theme of the qualification work, the diagram is transformed with structural changes: some categories become implicit, that is, they become "invisible" in the figure, decomposition is performed for other categories - the branches turn into trees.

![Ishikawa diagram of the "Longitudinal stability of rolling" problem](image-url)

Taking into account the technological orientation of research, the categories "man", "management", "measurement" become implicit when it is assumed that
personnel with a sufficient level of skills, abilities and competences are involved, management and measurements are carried out in accordance with modern requirements with the help of modern equipment with a sufficient level of scientific validity.

According to the topic of the work, the "Main equipment" category is divided into groups of cages: draft and finishing, continuous and sequential. Further, the rolling stands themselves can be subdivided according to the number of rolls: duo, quarto, six-roll, etc.; according to the design of the beds, etc. In the "Manufacturing" category, hot longitudinal rolling is selected, with a subdivision for sheet, graded, and shaped profile rolling. The "Material" category is subdivided into rolling material, tool material, lubricant, etc. The preliminary stage of the investigation of cause-and-effect relationships for the analysis of the longitudinal stability of hot rolling of coiled steel is presented in fig. 6.

A diagram was constructed that allows for a more detailed characterization of the conditions of longitudinal stability the hot rolling steel under the influence of production factors. The disadvantages of using the diagram include the difficulty of correctly determining the relationship between the investigated problem and the reasons why the problem is complex, that is, it is a component part of a more complex problem of increasing efficiency.

![Ishikawa diagram of the longitudinal stability the sheet steel rolling](image)

Fig. 6. Ishikawa diagram of the longitudinal stability the sheet steel rolling

In order to quantitatively assess the cause-and-effect relationships in this problem, one can move from the Ishikawa diagram to the cause-and-effect model of the object as a weighted graph.

Turning to information technologies allows you to increase the practical benefit and increase the focus of training. Opportunities to use differentiation and individualization in work with students are expanding; intragroup differentiation, involvement of students in socially significant activities, counseling, problem-based learning method, project method. One of these methods, which has a positive effect
on the development of the creative abilities the students, is conducting classroom works with elements of debate. Its use is justified when it is necessary to analyze a complex cognitive task. At the same time, it is necessary to choose an answer from several alternative options that have significant practical or theoretical interest. To involve all participants in active work, you can use the technique of joint learning and educational cooperation, based on work in small groups. Students use group intellectual potential to perform a common task or realize a common aim of solving a problem.

Work in a study group consists of several points:

1. Formulation of the problem situation. The teacher describes the problem and its outer circle, offers one of the options for solution a partial task. At the same time, the style of thinking, lines of argumentation, approaches to problem solving, and determination of the stages of its solution are demonstrated.

2. Formation of small groups from 3-5 students with creative potential and such that personal contradictions do not arise.

3. Discussion of the components by the problem in small groups after its decomposition at the beginning of the lesson.

4. Presentation of the results from the decisions of small groups for discussion in the entire study group after the end of the work time in small groups.

5. Fixation of positive and negative aspects from the results of the groups’ work.

During the discussion and presentation of results, the teacher manages this process (Fig. 7). He can clarify the problem, at certain moments provides additional data, prevents premature rejection of new ideas through the given questions and promotes the development of creative thinking and development of students’ teamwork skills.

![Diagram](image)

Fig. 7. Scheme of group work in the classroom

Problem-based learning is also characterized by the fact that it changes the motivation of cognitive activity: cognitive-stimulating (intellectual) motives become
the leading ones. Interest in learning arises in connection with a problem and unfolds in the process of group intellectual work related to searches and finding a solution to a problematic task or set of tasks according to educational planning of works.

Cognitive motivation encourages a person to develop his inclinations and capabilities. A mandatory stage of the joint work is the determination the achievement of positive results in solving the problem and the assessment of the contribution from each of the small groups.

One of the modern learning technologies in higher education is the case-study method. Case-study is a method of active problem-based situational analysis, based on learning how to solve specific tasks-situations (solving cases).

Case-studies begin with specific educational scenarios, which are specially developed based on real production situations for the purpose of further analysis in educational sessions. During the analysis of the situation, students learn to act in a "team", conduct analysis and take (management) professional level solutions.

The purpose of the case-study method is to activate the joint efforts of students in the analysis problem situation, finding its solution. The task of the case-study method is to develop the skills of a comprehensive analysis the problem situation; the ability to find the necessary information, its addition; skills of applying theoretical knowledge from various fields to analyze practical problems; establishing the reasons that led to the occurrence of this situation; skills of axiological analysis - building a system of evaluations the situation, its components, conditions, consequences, actors; prognostic analysis skills - preparation of a forecast regarding the likely potential and desired scenario of its development; skills of recommendation analysis (making recommendations regarding the behavior of actors in the situation) etc.

Stages of solving cases: acquaintance with the situation, its features; selection of the main problem (main problems), selection of factors and personalities that can really influence the course and result of solving this problem; offering concepts or topics for brainstorming; analysis of the consequences of making this or that decision; proposal of one or more options (sequence of actions), indication of possible problems, prevention and resolution mechanisms [18].

The problem of higher education and in modern conditions remains the development of students' scientific style of thinking (for example, understanding of applied mathematical methods and basic physical laws), the ability to apply it effectively.

The process of formation the fundamental and applied mathematical knowledge, abilities and skills at such a level that is sufficient for their effective application to solving problems that arise during the performance of professional functions, and further professional self-development of a specialist, requires constant innovations.

The social order of a high-tech society for the training of a modern specialist makes it necessary to carry out versatile training of students in accordance with the requirements of the time. Determinants in pedagogical activity mean a condition, cause or factor determining any process.

One of the determining techniques is learning to use various freely available digital materials or open educational resources. Some media can be counted among them: electronic textbooks; various manuals and methodical materials issued in
electronic form; databases of control and educational test tasks. Technologies and Internet platforms that provide access to knowledge in a remote form (Microsoft Teams, Zoom, Google class, Moodle) can also be included here. With a rational combination of various teaching methods, it is possible to increase the efficiency of the educational process. For example, electronic textbooks differ favorably from traditional textbooks in terms of clarity and the ability to create a vivid video series that enhances the emotional and personal perception of the studied material by students. As a result, the creation of electronic textbooks should become an important direction in the development of educational and methodological materials of the department.

Numerous developments in the field of educational technologies agree that the basis of e-learning is a carefully developed academic process in an electronic educational environment, supported by a systematically justified and purposeful sequence of educational, methodological and diagnostic materials that ensure the achievement of learning outcomes within the limits of exclusively digital learning. In fig. 8 it shows, for example, a graphic model of network learning using case technology.

![Diagram](image)

**Fig. 8. Online learning and case technologies**

So, let’s conclude that e-learning is a verbal process, basification of information using Internet technologies. E-learning implies social support for those seeking higher education. In full-time education, this mission is carried out with the help of the material potential from the university and teachers involved in the educational process. The distance learning is unthinkable without an appropriate IT base. And this base, in turn, requires significant investments, including in an e-learning platform, as well as high-quality courses that provide effective training.

In the conditions of the Covid-19 pandemic, universities had to establish the educational work of higher education students and teachers remotely both
synchronously and asynchronously in time in a server information and educational environment. In order to minimize difficulties and save time for students, the graduating departments of the Faculty of Applied Mathematics of O. Honchar DNU and the metallurgical faculty of DSTU actively and creatively rebuilt their work; the modernization of management, training and control methods in modern conditions was developed. The participants of the educational process used communication tools built into distance learning platforms (Moodle, Google Classroom, MS Teams), e-mail, messengers (Viber, Telegram, etc.), video conferences (ZOOM, Google Meet, Skype, etc.).

Defenses of qualification works using remote technologies was carried out in synchronous mode (video conference) with mandatory recording (video recording, audio recording, photo recording, etc.) of the defense process.

Conclusions. In modern conditions, the training of submitters requires the introduction of modern forms and methods of education, a significant restructuring of the process of activity of teachers and students, improvement of methodical and computer support on an innovative basis using a scientific approach.

Educology is devoted to systematic research in the field of education. The conceptual and methodological importance of synergistic ideas in educology is connected with the recognition of the ability of educational systems to self-develop not only due to material and information flows from the outside, but also due to the use of their internal capabilities.

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