

Features of Teaching System in Technical University

Olga A. Kuvshinova

Penza State University architects and construction
Penza, Russia
oly791702@mail.ru

Larisa A. Nainish

Penza State University architects and construction
Penza, Russia
nainish.larisa@yandex.ru

Abstract—The present time is marked by the regularity of higher education reforms. Of course, reforms are needed. Life changes and the education system must change too. Each reform requires some adjustment of the learning process. In this, the process should not be destroyed. To prevent this, people who implement reforms should know the laws of didactics, according to which the learning process functions. However, unfortunately, not all who work in the system of higher education know these laws. This is the teachers and administration of technical universities. The overwhelming majority of them have no idea about the laws of the functioning of the educational process, because they do not have a pedagogical education. Given how large a number of technical universities, it is easy to imagine how many people work in the field of education without pedagogical education.

Keywords— *teaching collective, student collective, learning subsystems, graphs.*

I. INTRODUCTION

Back in the days of the Renaissance, the great Leonardo da Vinci noted that science could only be called a field of knowledge that used mathematics as an evidence base [6,3]. But contrary to the validity of this statement, there are currently areas of knowledge that do not use mathematics, but are considered science. One of these sciences includes pedagogy. Evaluation of scientific research in this area relies mainly on the semantic theory of truth, which is caused by the contradictory statements of experts and gives rise to semantic paradoxes. This casts doubt on the pragmatic usefulness of the results of pedagogical research. Instead of finding a match with the reality of the research results, the emphasis is shifted to finding their correspondence to linguistic objects. The absence of a mathematical apparatus in pedagogy constantly stimulates attempts to find unambiguity in the interpretation of various terms, arousing heated debate about the "correctness" of their interpretation. But, despite this, the desired unambiguity has not yet been achieved.

II. MATERIALS AND METHODS

The conceptual apparatus of pedagogy is rather diffuse and represents rather a kind of conceptual veil that separates it from other areas of knowledge, on the one hand, and, on the other - this circumstance creates problems in the study of pedagogy. People with a technical education who are accustomed to mathematical clarity with great difficulty

perceive the concept of pedagogy. Although they need to know the laws of didactics. This knowledge would help to competently introduce various kinds of reforms without reducing the level of professional education. In fact, the opposite often happens.

The learning process, like any process, has content and technology. However, the attention of teachers of technical universities is concentrated mainly on the content of learning. Although not all is well here. In universities, the indicator of "degreeeness" is considered a priority. Therefore, to improve this indicator, teachers with a scientific degree, often transferred from one department to another. At the same time, no one pays attention to the fact that the teacher does not know the academic disciplines of the new department at all. He needs enough time to master the new academic disciplines. While the teacher is mastering them, one does not have to speak about the quality of teaching, because he knows neither the content nor the technology.

The need for pedagogical education of teachers of technical universities was also spoken by D.I. Mendeleev. Since the middle of the 19th century, this topic has not yet come off the agenda. The Ministry of Education and Science of the Russian Federation in the letter from August 25, 2015 No. AK-2453/06 states, "for the post of "university/college teacher" or "school teacher" it is necessary to get training on an additional professional program in the field of education and pedagogy". In this regard, the question arises: how to train teachers of technical universities? At first glance it's easy: you take a textbook on pedagogy and study. But this is only at first glance. In fact, there is a serious obstacle, which is due to the difference between humanitarian and technical education. Accustomed to mathematical clarity, technicians hardly understand the vagueness of formulations in textbooks on pedagogy. The situation becomes fatal if the studying person takes a textbook of another author. There, the same definitions are interpreted differently. Pedagogy is not a science: the technician declares. And he, it turns out, is right, in part. In pedagogy, mathematics is not used, but the laws of the functioning of the learning process are, which each author describes in words, as it seems to him, more "correct" than all the others do. As a result, the range of interpretation of the same law is quite wide. We should add that different people could understand the same verbal description in different ways [2]. Of course, attempts to mathematize pedagogy are

constantly arising. But mathematical models are not perceived by humanitarians and work only for a narrow circle of users [4].

Making pedagogy understandable for people with technical education can be done by another compromise way: to expound the laws of the learning process in terms of general theoretical sciences, for example, in terms of the general systems theory [1]. The popularity of this field of knowledge is so great that it is familiar to the overwhelming majority of people with technical education. The key in this theory is the concept of "system". The system is understood as a relatively stable ordering of elements and links, which is determined by the functions and goals of the system.

Based on the definition of the system, it can be divided into components, in other words, you can identify the structure. To do this, you need to enter some additional characteristics, which may differ in magnitude and significance. These differences make possible multivariate structuring of the system. There are larger parts that can also be divided into smaller parts form subsystems. To divide the system into elements, need to choose a variety of rules. As a result, each system has different structures. But there are the following limitations:

- 1) each subsystem (element) must perform a single function of the system, which is a subfunction;
- 2) subfunctions provide a link between subsystems;
- 3) all subsystems (elements), acting together, achieving the goal set for the system.

Let's see what kind of the system are formed by the learning process in the university. The goal of any university is effective preparation in the relevant areas. It is realized due to the solution of many different tasks, which turn out to be the goals of its subsystems (elements). Relative to the whole system, they are considered subgoals, the achievement of which is due to the corresponding functions. The main subsystems of the learning process and their subgoals and subfunctions are given in Table 1.

TABLE 1. SUBSYSTEMS OF LEARNING PROCESS

	Components of the learning system	Subgoals	Subfunctions
11	Pedagogical collective	Effective vocational training during the learning process	Organization and implementation of the students learning process
22	Material and technical equipment of the learning process	Comprehensive provision of learning process with educational and methodical literature, computer support, laboratory equipment, etc.	Development and application of educational and methodological literature, visual aids, etc.
33	Student collective	Gaining professional knowledge, abilities, skills and competences	Participation in the learning process
44	Features of training courses (logical	Ways of organizing training	The influence of the logical structures of

	structure	information	training courses on the organization of the learning process
55	University administration	Achieving the effective vocational training in accordance with the requirements of society	Regulation of the relationship between all components of the learning process in accordance with the requirements of society
66	Amount of study time	Conformity of the amount of study time to effective vocational training	Immediate impact on the level of quality of training by providing the necessary length of the learning process
77	Economic cost	Comprehensive economic support for the learning process	Mediate impact on the level of quality of education through the economic support of the learning process

Let us consider the relationships that arise between pairs of distinguished subsystems and construct a graph modeling these relationships:

1. Pedagogical collective – Student collective. The interrelationship of the pedagogical collective with the student collective is central in the learning process. Their immediate and mediate relationships are the essence of the learning process [14,13].
2. Pedagogical collective – Features of training courses. Each teacher must know the training course that he teaches, its place in the curriculum system, the relationship with the basic training courses and with those for whom this course is basic. In addition, the teacher must know all the latest achievements in the field of knowledge, to which he involves students. The importance of this circumstance is difficult to overestimate as in the cognitive, psychological and methodological plans. First, the knowledge carried by the teacher to students must be reliable, their volume must meet the standard. Secondly, the impeccable knowledge of their training course gives confidence to the teacher, which is a very important factor. If the teacher is not self-confident, then students in the audience instantly understand it. As a result, the response of students can disrupt the learning process. Thirdly, the teacher must know the logical structure of the training course. It is one of the most important characteristics that influences teaching methods. Technical universities are dominated by mathematics-based training courses, the logical structures of which are highly connected. The peculiarity of the teaching methods of these courses is that it is necessary to use the current quality control of knowledge and an appropriate level of basic knowledge is necessary. These training courses are made according to the standard, and the teacher cannot influence them. As a result, the relationship between this pair of subsystems does not have symmetry. The teacher is obliged, following the features of the training course, to select and implement the appropriate technology of training. The line connecting the vertices that model the subsystems of the teaching staff and the features of the training courses turns out to be an arc. This arc is

oriented to the top, which corresponds to the pedagogical collective [10,9].

3. Pedagogical collective – University administration. This interrelationship is basically a relationship of submission. In order to successfully operate the educational process, the teacher should be subject to the influence of the administration. If the actions of the administration are not contrary to the laws and principles of didactics. But representatives of the administration are, as a rule, the same teachers who are not burdened with knowledge of pedagogy. As a result, their decisions are not always adequate to the laws of didactics. This inadequacy leads to the destruction of the learning process. The objections of teachers who understand the reasons for this lack are often not taken into account by the administration. Because the expansion of the rights of the administration often leads to the formation of a rigid vertical of power within the university. As a result, the influence of the teaching staff on the administration is insignificant or non-existent. Thus, the influence in the pair of the university administration - the teaching staff is asymmetrical. This influence is modeled by an arc oriented to the top of the subsystem “pedagogical collective”.
4. Pedagogical collective – Material and technical equipment of the learning process. The material and technical equipment of the educational process consists of two parts: an educational and methodical complex and equipment for training, lecture halls and laboratories. The educational-methodical complex is developed by university teachers. One of the features of a technical university is the lack of knowledge of the laws and principles of didactics in most teachers and not understanding the meaning of teaching technologies in the educational process. This often leads them to a formal attitude towards the development of educational-methodical complexes. It is reinforced by constant changes in the FGOS, which require constant changes in the methodological support. It takes a lot of time that exceeds the planned load. As a result, methodological support is performed at such a low level. But, one way or another, teachers are influencing this component of material and technical equipment. The other component affects teachers, requiring them to master the technical equipment of various classrooms and laboratories. As a result, we have the mutual influence of these two subsystems, which corresponds to the edge of the graph modeling this system.
5. Pedagogical collective – Amount of study time.

The amount of study time is one of the components of the teaching load. In order to rationally distribute this time, the teacher must relate it to the number of students per teacher, to their learning and to the logical structure of the course. Technical disciplines that have a high degree of coherence of logical structures require from students an appropriate degree of training and an

appropriate amount of study time. But after the introduction of a single exam, the required compliance, as a rule, does not arise. To restore the students' appropriate training, it is necessary to increase the amount of time allotted for the development of the training course. But it has a steady downward trend. As a result, study time is reduced to such an extent that it is impossible to include these structures in it, not to mention the correction of students' training. The hopes of teachers to increase this time are in vain. The weak level of propaedeutic training leads to the fact that students in the first course are recruited very many. This causes the actual increase in the amount of study time, which the teacher has to fill out of his personal time. All this testifies to the complete dependence of the pedagogical collective on the amount of study time. On the graph, this dependence is depicted by an arc, which is oriented towards the top, corresponding to the pedagogical [5,8].

6. Pedagogical collective – Economic cost. The economic component is immediately connected with the teacher through the amount of their wage, and is mediated through the quality of the material and technical equipment of the learning process. The impact of the teaching staff on the economic component is absent.
7. Student collective – Features of training courses. The link of students with training courses is one of the strongest, as training courses in their totality determine the features of the chosen profession, which the student must learn [11,7].
8. Student collective – University administration. Administration of the university in accordance with the legal norms and requirements of the society is responsible for the regulation of relations within the student collective and motivates the effective mastering of the curriculum.
9. Student collective – Material and technical equipment of the learning process. Mastering the educational material, students use educational and methodical literature, laboratory equipment, classrooms, computer classes, etc. In turn, the level of student training requires adjustments in material and technical equipment.
10. Student collective – Amount of study time. These two subsystems are bound by the established norms on distribution, on the one hand, and the independent distribution of this time, on the other hand [12].
11. Student collective – Economic cost. The economic component determines the amount of students' scholarships and the quality of the material and technical equipment of the learning process.
12. Features of training courses – University administration. The logical structure of the training course as its dominant feature determines the technology of learning this course. Technology, as it is known, is a complex concept, which includes the material and technical equipment of the educational

process, the amount of study time, etc. Ideally, the university administration should know these features and react accordingly. Allocate study time in such a way that the logical structures of these courses are not destroyed. Acquire such material and technical equipment so that it contributes to the successful completion of these courses. Match the level of pedagogical qualifications. Using the FGOS of the corresponding generation, the administration should regulate the development of curricula, which would take into account the hierarchy of all training courses. As a result, the features of training courses should influence the actions of the administrative subsystem. But at a technical university representatives of the administration do not always possess this knowledge. As a result, the features of training courses do not have the desired effect on administrations. On the graph, the ideal attitude of the administration to the training courses was demonstrated: the actions of the administration take into account the features of the training courses. Therefore, on the graph, the corresponding vertices are connected by an arc directed to the top of the “university administration”

13. Features of training courses – Material and technical equipment of the learning process. Different in their content and logical structure, training courses require different equipment in the process of studying them.
14. Features of training courses – Economic cost. Features of the logical structure of various training courses require a different amount of study time, different material and technical equipment, different qualifications of teachers. As a result, their mastering requires different economic costs, which should be taken into account when funding universities.
15. Features of training courses – Amount of study time. The logical structure of the training course is closely related to the amount of study time. This relationship is determined by the necessary correspondence, which does not allow destroying the connectivity of the logical structure.
16. University administration – Material and technical equipment of the learning process. The administration of the university accepts decision on the distribution of material and technical equipment, its updating, etc. This function determines the interrelationship between these two subsystems.
17. University administration – Amount of study time. The amount of study time is determined by the Federal State Educational Standards, which provides an possibility for the administration to distribute it. This circumstance determines the interrelationship of these subsystems.
18. University administration – Economic cost. One of the main functions of the administration of the university is the distribution of material resources, which allows regulating the quality of learning.

19. Material and technical equipment of the learning process – Amount of study time. Dependence of these two subsystems is determined by the following: the less study time is spent, the more and better will be the equipment of the learning process.

20. Material and technical equipment of the learning process – Economic cost. The link between these subsystems is immediate. The quality and quantity of the components of the material and technical equipment of the learning process directly depends on the economic costs allocated to it. The more funds are allocated, the more effective is the material and technical support of the learning process.

21. Amount of study time – Economic cost. The importance of this interrelationship is due to all previous interrelationships of the allocated subsystems and economic cost.

III. RESULTS

The interrelationship of the allocated elements, which is described above, allows us to state that it is the structure of the learning process. Each element affects each one. The scheme of this interrelationship is represented by the graph in Fig. 1 [5]. The condition for its existence is the set of distinguished subsystems and the relation that is given on this set.

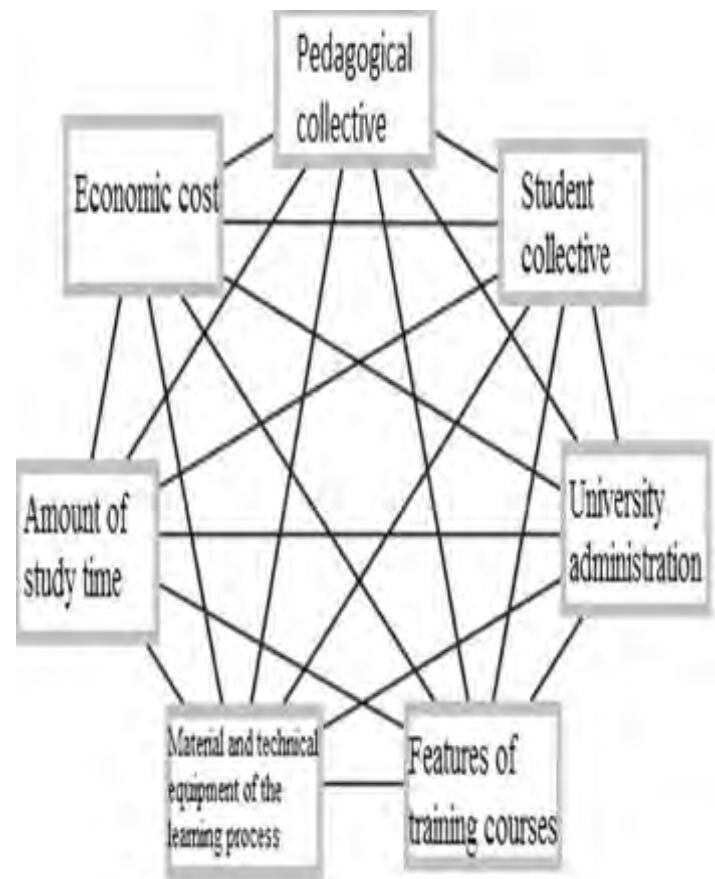


Fig. 1. The scheme of the structure of the learning process

Usually the elements of the set (in our case - the learning process subsystems) are represented by points on the plane and are called the vertices of the graph. If necessary, they are labeled. In our case, the vertices of the graph have sufficiently detailed labels. Therefore, they are not represented by points, but by rectangles, in which labels are inscribed. The relation on the set of elements in the general form is formulated as follows: "the element X affects the element Y". The specific formulation of the relationship depends on the specific goal and specific functions of the system [15].

IV. CONCLUSIONS

1. Each vertex is associated with each. In other words, we have a complete graph. This indicates a high degree of connectivity of the subsystems of the learning process.
2. Since the vertices are connected mainly by arcs, this is a directed graph. Such graph allows you to clearly identify the hierarchy in the training system modeled by him. To do this, use the following rule: the more arcs are included in the element, the more it depends on other elements.
3. Let us consider the features of the hierarchical structure of the system of higher technical education. The vertices of the graphs, which model the economic component, features of training courses and the administration of the university, has five outgoing arcs. These subsystems have a powerful influence on all components of the learning process. This indicates their dominant position in the system of vocational technical education. But the lack of knowledge of pedagogy among the representatives of the administration of these universities does not make it possible to correctly prioritize. For example, the priority of the economic component in the quality of education leads to a reduction in the amount of study time to a size that does not fall under the framework of the logical structures of training courses. In addition, it is not possible to eliminate the shortcomings of the first-year students in propaedeutic training within the framework of the university. This actually leads to the impossibility of their further education. As a result, the level of training of graduates does not meet the requirements of modern society.
4. The number of incoming arcs in the peak, which models the pedagogical team, is second only to the peak "student team". This demonstrates the powerful dependence of university teachers on all elements of the training system. Although the main purpose of the system under consideration is training. In accordance with this goal, the subsystem of the pedagogical team should dominate in the university hierarchy. But the system of a technical university, which on the presented model is even somewhat idealized, the pedagogue is an extremely dependent element. Although by right a pedagogue is a central figure in the system of education. According to the authors, one of the reasons that gave rise to this situation is the lack of understanding of the importance of the teacher in the

learning process. This importance determines the corresponding rights, which the pedagogues of technical universities do not even suspect. And who does not know his rights, he does not own them. One of the important conditions that will allow you to master your rights is the knowledge of pedagogy. But, unfortunately, such knowledge is missing. But the saddest thing is that the teachers of technical universities do not have the motivation to acquire them.

5. The learning process is a very complex system and a very cohesive system, where any change in one of the subsystems will lead to a change in the entire system. Thus, if it becomes necessary to introduce some changes in the educational process, then all its connections should be taken into account. Otherwise, you can destroy it.

V. DISCUSSION

When writing the article, the authors used the results obtained during the professional retraining course "Pedagogue in Higher Education"

- An algorithm for creating an optimal learning technology is proposed, which gives the highest possible learning outcomes with minimal economic, time and other costs.
- Designed for the perception of people with technical education. This was made possible by presenting the basic laws of the educational process in terms of general scientific methods and disciplines, such as general systems theory, optimization theory, theory of organizational relationships, graph theory, multidimensional geometry, theoretical cybernetics, and geometric modeling.

References

1. L. Bertalanffy, *The general theory of systems*, Moskow: System modeling, 1969.
2. K.I. Valkov, "Lectures on the basics of geometric modeling", Leningrad: Leningrad State University, 1975, p. 180.
3. L.A. "Pedagogy in a technical college - problems and solutions", *Educational environment today and tomorrow*, Moskow, 2006, pp. 103–109.
4. L.A. Nainish, "Improving the efficiency of the educational process using a mathematical model. Sat 111 All-Russian scientific-practical conference", *Russian education in the 21st century: problems and prospects*: Penza AMOO Volga House of Knowledge, 2007, pp. 58-61.
5. F. Harari, *Graph Theory*, Moskow: Mir, 1973, p. 300
6. L.A. Nainish, O.I. Lazareva, "The structure of the system of individual student learning paths", *Theory and practice of the development of modern education in Russia*, collective monograph, Ulyanovsk, 2017, pp. 57 - 64.
7. Nainish L.A., Lazareva O.I., Golubinskaya T.V., "Harrington's desirability function for measuring professional competence", *Alma mater (Herald of Higher Education)*, 2016, vol. 1, pp. 60-66.
8. L.A. Nainish, E.M. Silence, "The use of organizational links in the educational process", *Education and science in the modern world, Innovation*, 2016, No. 5, pp. 30-39.
9. L.A. Nainish, S.A. Boldyrev, T.V. Golubinskaya, "Universal technology of education as a means of solving the problems of pedagogy of a

- technical college”, *Alma mater (High School Bulletin)*, 2015, vol. 1. pp. 71-75.
10. L.A. Nainish, V.V. Gorbunova, T.V. Golubinskaya, “Personality of a teacher of a technical college of the 21st century”, *XXI century: results of the past and problems of the present plus*, 2015, vol. 2, № 1 (23), pp. 112-116.
 11. L.A. Nainish, T.V. Golubinsky, O.A. Kuvshinova, “Features of the reform of higher technical school”, *The azimuth of scientific research: pedagogy and psychology*, 2018, vol. 7, No. 3 (24), pp. 1336-1339.
 12. L.A. Nainish, V.V. Burlov, L.V. Remontova, “Study time and quality of vocational training in the system of higher education in Russia”, *XXI century: results of the past and problems of the present plus*, 2014, No. 4, pp. 227-230.
 13. L.A. Nainish, M.A. Gavrilov, “Formation algorithm for optimal learning technology”, *European science review*, № 7-8, 2014, pp. 53-55.
 14. L.A. Nainish, V.V. Burlov, L.V. Remontova, “Personality as a goal of modern education”, *XXI century: results of the past and problems of the present plus*, 2013, № 4 (18), pp. 16-21.
 15. L.A. Nainish, L.E. Gavrilyuk, “Problems of vocational training of students of technical universities by means of geometrical-graphic disciplines”, *Alma mater (Higher School Bulletin)*, 2013, vol. 4, pp. 88-91.