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THE POSSIBILITIES OF INFORMATION AND EDUCATIONAL ENVIRONMENT AT A TECHNICAL UNIVERSITY

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Abstract

Traditionally education is associated with the category of a “process”, which implies the presence of a single logic of teaching and learning, in which the interaction of a teacher with a student is absolute, and all other forms of activity are mainly auxiliary. Indeed, Russian traditional university education represents a linear system (more exactly, a process), which includes the following: consistent presentation of new information and its practice; regulation of the teacher-student activities in accordance with some previously developed plans (closeness of informational and the educational process); absence or inefficiency of interaction between students during study, etc. The idea is to move from a procedural description of educational systems based on linear principles to a category of information and educational environment, which includes all the variety of subjects of educational activity (a teacher and students), the means used by them and, most importantly, the interactions between them. The study made it possible to design a model of the information and educational environment of students’ mathematical training, to carry out a pedagogical experiment and to conduct a comparative analysis of the effectiveness of teaching discrete mathematics within the framework of the traditional system of education and within the information and educational environment. The comparative analysis of psychological and pedagogical aspects of training effectiveness according to the traditional scheme and training within the framework of the information and educational environment proves the efficiency of the latter.

Keywords: Discrete mathematics, education, information and educational environment

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1. Introduction

The target and value objectives of domestic higher education have qualitatively changed in recent decades. The general humanitarian problems of personality development, the formation of an adequate professional identity and successful professional socialization of a young person as the basis for an ongoing career come to the fore. A generalized conceptual model addressing all the above problems is the paradigm of learner-centered approach to education (Hutorskoj, 2003). At the same time, there is a need to develop the conditions and modalities for the practical implementation of the principles of this approach in relation to higher vocational education. Besides, there are some specific problems related to the training of mathematics and natural sciences within basic professional educational programs of higher education, bachelor programs majoring in 10.03.01 Information Security (further – students).

There are certain traditions of scientific education at school and the university that objectively complicate the perception: monologic, low level of mutual personal acceptance between a teacher and students, remoteness of the studied content from the immediate vital interests of a young person.

Qualitative changes in cultural and educational aspects of higher education at the turn of the centuries play a significant role in the formation of the problematic field of studying mathematics and natural sciences at the university. In particular, recent decades have been marked by an avalanche-like increase in information flows, the introduction of modern information technologies into all infrastructures of the modern society, and the formation of the need for universal computer and information literacy (Selevko, 1998). Against the same background, the system of domestic education is being integrated into the global world educational space.

Thus, the relevance of this study is explained by the combination of several factors and trends:

- implementation of the modernization policy objectives of domestic education, including education quality improvement, informatization of the educational environment (primarily due to the introduction of information technologies), increased role of distance learning;
- need for practical implementation of the fundamental principles of humanization and humanitarization of higher education;
- improvement of professional culture of university teachers and transition to competence-based models of formation and evaluation of learning outcomes and educational results (Bissenbayeva et al., 2014).

Accordingly, the development of the concept, modeling and practical implementation of the Information and Educational Environment of Mathematical Training of Students seems to be an urgent scientific and practical task.

The main contradictions addressed in this study are as follows:

- contradiction between the requirements of the state educational standard of higher professional education, which sets the common objectives for all students, and significantly different individual abilities and the level of aspiration of each student;
- contradiction between socio-communicative features and cognitive dominants of modern students, and the traditions of scientific education at the university;

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- contradiction between the predominantly knowledge content of standard courses and spontaneously developing personal-competence approach to professional education among both teachers and students;
- contradiction between the traditional "linear" logic of the educational process at the university (including the movement "from simple to complex") and the experience of substantially non-linear interaction of each student in the modern cultural and information environment.

The study hypothesis is the information and educational environment as a significant factor in improving the quality of mathematical training of students under the following conditions:

- conceptual: information and educational environment is formed in the context of the principles of modern humanitarian knowledge, including nonlinearity, openness, communicativeness, scalability, etc.;
- personal: teachers and students form an adequate image of the information and educational environment as a space of interpersonal dialogue and personal self-realization of all participants in educational interaction;
- technological: educational interaction is carried out in a variety of mutually complementary ways, both in person and remotely, thus updating the joint forms of educational activity of students, standardized forms of diagnostics of academic performance and group reflection of the main learning outcomes (Beard & Wilson, 2006).

2. Problem Statement

The main objective of this study is to determine the theoretical bases and practical possibilities of a nonlinear open communicative information and educational environment, which allows achieving a higher quality of education in the process of studying Discrete Mathematics by means of intensifying educational interaction and using modern information and communication technologies.

3. Research Questions

The subject of the study includes:

- scientific and project-based support (concept, content, model of development and implementation) of the educational and information environment of mathematical training.

4. Purpose of the Study

The purpose of the study is to create a model of the information and educational environment of mathematical training of students, which ensures the implementation of the principles of the person-centered approach; goals and values of modernization of domestic education; and the systematic integration of information and educational environment of certain training courses into higher-level information and educational environment.

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5. Research Methods

Systematic experimental testing of the impact of the information and educational environment on the quality and structure of educational activities of students was carried out from 01.09.2021 to 01.01.2022. This stage included practical verification of the developed theoretical provisions and their adjustment; introduction of a new course in the educational process of MIREA – Russian Technological University. The main methods of study included pedagogical experiment, observation, testing, questionnaire, interviewing, comparative analysis, analysis and synthesis of results, methods of mathematical statistics.

6. Findings

Let us consider the ideas of one of the most fervent advocates of the classical didactic programming by Gagne (1985) as a starting point for the theoretical modeling of the information and educational environment. In his work, the learning process is considered as a sequential change of nine phases (each of which requires the satisfaction of different conditions for the optimal learning process): attention and motivation; selective perception of characteristics; short-term memory; repetition; semantic coding; storage in long-term memory; search and reproduction of information; practical application; feedback. Let us briefly describe some of the major problems arising from the linearity of the learning process.

Attention. In order for the learning process to begin, a student shall pay attention to the object of knowledge or completely focus on it. But in the conditions of the traditional system of education the ability of a teacher as a medium of new information and, accordingly, an object of attention is quite limited, and therefore, with an increase in the number of students, even in the most interested audience, there is a noticeable distraction of attention.

Motivation. The initial phase of the learning process is motivation, i.e. a student strives to achieve some personal goal. As a rule, in a traditionally organized process, basic importance is given to cognitive motives. However, practice shows that for most students operational and communicative motives are more important, which usually has a negative impact on a linearly organized process.

Selective perception of characteristics. Students should not only get an impression of the information presented, but also focus on its characteristics. The very problem of identifying its essential and non-essential components seems quite complex. In particular, the success of the system of innovative teachers S.N. Lysenkova and V.F. Shatalov owes much to the solution of this issue. In modern conditions, the recording of fundamentally important elements of the studied material can be efficiently carried out using computer and information technologies.

Semantic coding. New information coming into long-term memory should be separated from redundant verbal images and transformed into more stable value-meaning patterns. It is necessary to note the possibilities of interpersonal communication and interaction with computer and information technologies to optimize this process.

Storage in long-term memory. It is very important that, according to the known serial position effect (B.V. Zeigarnik), the quality of memorization turns out to be the higher, the less homogeneous the

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information. Thus, the most adequate way of learning is not an ordered set of some representations, but a rather complex network that joins visual, verbal and motor representations (semantic network according to R. Gagne).

A model of an open non-linear information and educational environment is proposed as one of the possible strategies to all these problems. The model is characterized by the following features:

- presence of many subjects of educational interaction, objects of cognitive and transformative activity accessible to them, as well as the whole set of communications between them;
- presence of many interactions between subjects and objects that are not ordered within a single logic (non-linearity of the environment);
- ability to integrate traditional information sources (books, reference books), modern information sources, including remote (Internet), as well as software products used for illustrative and heuristic purposes.

The simplest component of the information and educational environment is an educational module, which is a relatively complete and autonomous component of the educational environment characterized by a certain content and efficiency; each module is characterized by multilevel interaction between all participants in the educational process; has a specific internal structure, solvable pedagogical tasks and a specific (measurable) result.

During the study, the possibilities of the following modules were studied:

- Complex Problematization – providing at the same time the problematic grounds of the material being studied in connection with the psychological and pedagogical peculiarities of its study and absorption. The structure of the module highlights the following elements: presentation of situations of professional use of the studied information, discussion of the primary image of the studied material, self-assessment of learning difficulties, justification of the “key problems” of the studied material, etc.
- Formation of the information field – creating the necessary information support for the educational process within the framework of a certain topic. The content of the textbook, lecture course, task book is analyzed, information sources from the Internet are selected and discussed.
- Interaction planning – constructing many individual educational trajectories that allow achieving the optimal level of training. The structure of this module implies the creation of an information bank for work, the discussion and differentiation of algorithms to solve typical and creative tasks within the topic, the determination of its most complex elements, the formation of an individual level of aspirations (learning outcomes).
- Complex solution – creating conditions for mutual assistance and effective interaction between students in the process of developing practical problem-solving skills. The elements of the module include the preliminary assessment of complexity of problems, classification of problems by types and algorithms of solution, peer-review of the correctness of chosen solution, etc.

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- Examination and control – determining the effectiveness (quality) of studying content both for the whole group and for each student individually. This includes testing procedures and psychological interviews.

This approach was used in teaching the following sections of Discrete Mathematics: Sets, Plots, Correspondences, Relations; Boolean Functions; Algorithm Theory; Predicates; Combinatorics; Finite-State Automaton for second-year students.

Let us give a comparative analysis of the results of teaching Discrete Mathematics within the framework of the traditional system and within the framework of the information and educational environment. The choice of this particular discipline for the pedagogical experiment was caused by the fact that for a number of years students called this subject the most difficult and requiring a lot of time and intellectual effort. Two methodological approaches to teaching Discrete Mathematics were tested in student groups. The education programs were compiled in full compliance with the program requirements of the state educational standard. The first methodology (used in group K, or control group) was as follows:

- it was based on the traditional teaching method;
- a multivariable set of fixed homework, independent and control tests were used.

Based on the creation of an information and educational environment the distinctive provisions of the second teaching methodology (in group E, or experimental) were as follows:

- creation of educational interaction situations (Palloff & Pratt, 2005);
- application of computer and information technologies;
- application of modular teaching technology using network planning elements;
- reliance on individual psychological features of perception and interaction in course planning;
- variability in the methods of presenting the studied material;
- selection and distribution of materials according to the levels of complexity depending on the individual level of knowledge so that a student feels his progress (Serikov et al., 2015);
- use of tasks that contribute to the development of communication skills.

Assessment and control tests were carried out in the process of studying discrete mathematics (3rd semester).

The test results are shown in the Table 1.

Table 1. Test results of groups E and K in 2021

Test No.	Entrance test	1	2	3	4
Test date	01.09.2021	08.09.2021	15.10.2021	22.11.2021	29.12.2021
Maximum score	100	100	100	100	100
Average in group K	62.7	60.9	65.9	65.7	70.2
Root-mean-square deviation (K)	12.6	17.6	37.6	38.1	58.1
Average in group K	60.5	69.9	69.9	70.7	76.5
Root-mean-square deviation (K)	19.8	18.8	48.8	43.2	53.2
Significance level of differences	>0.1	0.005	0.01	0.005	0.001

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The entrance test of students showed no statistically significant differences in the level of initial training. The processing the results of the remaining four tests revealed a number of patterns. Students who studied Discrete Mathematics based on the second methodology (group E) had a statistically significant increase in the proportion of excellent and good grades in exams (fourth test). Group K was characterized by the inverse dependence: the number of excellent and good results of students in the exam decreased, while the number of satisfactory results increased. Besides, the average score obtained in all four tests in group E is higher than in group K with reliability not less than 0.01. This confirms the sustainability of a positive outcome.

7. Conclusion

It is known that the main didactic task in junior courses is to adapt yesterday's schoolchildren to the new educational system. Its successful solution is facilitated by the peculiarities of students' personal development noted in the process of informal observation and interviewing, for which the group E students are characterized by higher performance, self-esteem, adaptability, activity in the search for non-standard problem-solving methods. Thus, the comparative analysis of the psychological and pedagogical aspects of the effectiveness of training according to the traditional scheme and training within the framework of an integrated information and educational environment proves the efficiency of the latter.

References

Beard, C. M., & Wilson, J. P. (2006). *Experiential learning: a best practice handbook for educators and trainers.* Kogan Page Publishers.

Bissenbayeva, V., Aurenova, M., & Uaidullakyzy, E. (2014). Modern technologies of communicative competence formation. *Procedia Social and Behavioral Sciences, 116*, 4780.

Gagne R. M. (1985). *The conditions of learning.* Holt, Rienhart & Winston.

Hutorskoj, A. V. (2003). Key competences as a component of personally oriented educational paradigm**.** *Narodnoe obrazovanie, 2*, 18.

Palloff, R. M., & Pratt, K. (2005). *Collaborating online: Learning together in community.* Jossey-Bass.

Selevko, G. K. (1998). *Modern educational technologies*. Public education.

Serikov, V. V., Pichugina, V., & Saurenko, N. (2015). Project Approach as the Methodology of Constructing the Content and Technology of University Education. *Procedia Social and Behavioral Sciences, 214*, 399.