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ORGANIZATION OF A COMMON INFORMATION SPACE IN THE TEACHING OF MATHEMATICS, USING THE SYNERGETIC APPROACH

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ABSTRACT

The issues of organization of the process of teaching mathematicsin higher educational institutions, with the use of synergetic approach, based on the implementation of a common information educational space, are considered in the article.When implementing the process of teaching mathematics with the use of synergetic approach, it is implied that university students carry out complex scientific-research projects, within the framework of small groups, in terms of a dialogue of mathematical, information and various natural-science and humanitarian cultures. The essence of each of the projects is a multifaceted study of complex mathematical objects and processes by students of small groups, from the point of view of integrationof the arbitrarily obtained components of the finite set of initially existing chaotic complex of knowledge and skills of students. It is done with the purpose of development the complex mathematical models of objects, with the possibility of creation of various systems with their unique properties, characteristics and principles. The use of synergetic approach in the integration of complexscientific-research projects and distance learning allows to form the fundamentally new common information and education environment, which integrates knowledge from various scientific fields and academic disciplines. The implementation of such innovative method of teaching mathematics is of multi-stage nature. Individual representatives of each of the small groups carry out the corresponding profile activity, aimed at achieving the overall goal of the small group, within the framework of each stage.

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To organize the process of teaching mathematics in terms of considering the dialogue of cultures, using the synergetic approach, it is proposed to use the information environment, developed by V. V. Bogun, in the framework of a common information and education space.
Keywords: common information and education environment, synergetic approach, teaching mathematics, dialogue of cultures, natural science disciplines, remote system of dynamic calculation projects.

Relevance of the problem

The main drawback of modern mathematical education is the universal application of complex multi-level abstractions, with the use of symbolic components, in the consideration of mathematical objects. In most cases, this leads to their learning by students without proper organization and ensuring the effectiveness of cognitive processes. To solve this problem, it is necessary to provide technological support for cognitive activity, which will focus on the manifestation of synergetic effects in the process of identifying and updating of generalized constructions of modern scientific knowledge, and their subsequent adaptation to the content of mathematical education of the future specialist. This approach implies the identification of the main synergetic attributes both within the framework of the study of mathematical objects themselves, and in terms of the organization of educational activity, with the aim of detectionthe bifurcation transitions to higher stages of development of intellectual operations and thinking of students (V.V.Davydov, P.Ya. Galperin, E.I. Smirnov, N.F.Talyzina, V.D.Shadrikov, and others).

The realization of synergetic approach in the students' study of complex mathematical objects, from the point of view of the dialogue of mathematical, information, natural-science and humanitarian cultures, is directly connected with the interpretation of modern achievements in science, and their adaptation to the available state of mathematical experience, on the basis of information and communication technologies, and the integration of knowledge from various scientific and applied fields [1..4]. Such a fundamentally new concept of teaching mathematics will create conditions for increasing the educational and professional motivation of students, the quality of mastering mathematical knowledge and actions, the effective development of intellectual thinking operations, with the possibility of self-development and the manifestation of individual creative independence.

Synergetics as a science considers the objects of animate and inanimate nature within the framework of various phenomena and processes, from the point of view of complex self-organizing systems, and shows that all the processes and phenomena are associated with a

constant exchange of matter, energy, information with the environment, which inevitably makes them unbalanced. The analysis of the behavior of such systems "far from equilibrium" found that systems acquired fundamentally new properties, and began to obey special laws. In terms of studying various processes and phenomena, synergetic approach consist in a certain finite set of objects, which combining in an arbitrary way, can create different systems with their unique properties, characteristics and principles [2..5].

In particular, when implementing the process of teaching mathematics with the use of synergetic approach, it is implied that university students carry out complex scientific-research projects, within the framework of small groups, in terms of a dialogue of mathematical, information and various natural-science and humanitarian cultures. The essence of each of the projects is a multifaceted study of complex mathematical objects and processes by students of small groups, from the point of view of integration of the arbitrarily obtained components of the finite set of initially existing chaotic complex of knowledge and skills of students. It is done with the purpose of development the complex mathematical models of objects, with the possibility of creation of various systems with their unique properties, characteristics and principles.

Methodology for teaching mathematics, using the synergetic approach with a dialogue of cultures

Application of synergetic approach to the process of teaching mathematics in terms of a dialogue of mathematical, information and various natural-science and humanitarian cultures, in combination with comprehensive and multi-stage application of the common information and education space, developed by V.V. Bogun, should promote self-organization, self-development and qualitative changes of the student’s personality. This is due to the fact, that when the students implement scientific-research and development activities, there are the processes of knowledge generation by the students themselves, their productive creativity, the awakening of thestudent’s own resources, and theinitiation to one of his own development paths.

Identification of the probability of manifestation of synergetic effects and mechanisms of personality’s self-organization is possible due to the innovative technology of synergy manifestation in mathematical education, developed by E.I. Smirnov.It "represents the individual's readiness for gradual mastering of mathematical activity, combining the synergetic effects of deployment of theoretical or object-essential (acquisition of experience), process-activity (application and transformation of experience), personality-adaptive

(development of personal characteristics, intelligence) components of technology for solving complex problems, in the context of realizing personal preferences, with a high level of development of educational and professional motivation"[2..3].

E.I. Smirnov [3] defined and characterized four stages of the manifestation of mathematical education synergy, based on the actualization of the dialogue of mathematical, information, natural-science and humanitarian cultures: preparatory and organizational, substantive-technological, control-correctional and generalizing-transforming.

Stage I. Preparatory and organizational (reflection of the functionality of the system state parameters)

At this stage, the initial mastering of the essence of the considered mathematical process or phenomenon is carried out, in accordance with the application of synergetic approach, from the point of view of identifying the *"problem zone"* of mathematics. The means for the solving of this problem is the search and study of the generalized construct of scientific knowledge, with the subsequent adaptation to the available level of mathematical knowledge and methods,through the prism of the dialogue of mathematical, informational, natural-science and humanitarian cultures,in terms of comprehensive use of the common information and education space, developed by V.V. Bogun.

The main tasks of this stageare the following: to identify the problem points and difficulties in achieving the success of cognitive mathematical activity of bachelor students; to actualize and to form the thesaurus of synergy of mathematical education: fluctuations, bifurcation points, strange attractors, etc.; to reveal the peculiarities and preferences of students in mental processes, motivation and reflection, creativity and communicative activity; to form stable motives for the search and development of the new in cognitive mathematical activity, to study the functional features of the common information and education environment, and to implement the activities, required for this stage, with information.

Stage2. Substantive-technological (reflection of processability of the system's functioningparameters)

*At this stage,*there is the development of generalized construct of the "problem zone", revealed at the first stage, in the process of performing the functional analysis of the behavior of mathematical objects, within the framework of the considered process or phenomenon, after overcoming the bifurcation point, in accordance with the synergetic approach. The functional dependencies of the objects' behavior are developed from the point of view of the parameters'variability and the conditions for the realization of functions, through the prism of the dialogue of mathematical, information, natural-science and humanitarian cultures, using

the common information and education environment. From the pedagogical perspective, the technological parameters of system functioning of students' adaptation to obtaining new complex knowledge and results, through the prism of the state of mathematical knowledge and the methods of student's learning activity are investigated at this stage.

*The main tasks of this stageare the following:*using the tools of mathematical and computer simulation, to master the substantive constructs of the adaptation methods of generalized scientific knowledge to the available state of mathematical knowledgeand the ways of student's professional activity; to reveal and justify new mathematical results in the process of mastering and studying the generalized construct; to ensure a high level of professional motivation of students; to reflect the thesaurus of synergy of mathematical education in the course of research activity; to develop the adaptation skills, to improve himself in social communications, on the basis of a dialogue of mathematical, information, natural-science and humanitarian cultures, to learn how to present the results of mathematical and computer modeling, implemented in external information environments in thecommon information and education environment, and also to learn how to develop visual mathematical models within the framework of the presented program shell inside the common information and education space.

Stage 3. Evaluating and correctional (reflection of the relevance and effectiveness of the used technological solutions)

At this stage, a comparative analysis of the methods and procedures for finding the results of computation processes, performed on the developed generalized construct of complex mathematical knowledge, in accordance with the "problem zone", identified at the first stage, based on varying conditions and data values, as well as evaluation the choice of the optimal way to solve the problem, using a synergistic approach, are made.In the process of students'scientific and research activity, multiple monitoring of the results of students' innovative activity is carried out within the framework of using thecommon information and educationenvironment, revealing of positive and negative dynamics of parameters and indicators of cognitive activity, changes in the experience and personal qualities of the student,in terms of dialogue of mathematical, information, natural-science and humanitarian cultures.

The main tasks of this stageare the following: to monitor the results of students' innovation activities; to identifythe positive and negative dynamics of parameters and indicators of the innovation process functioning, the changes in the experience and personal qualities of students with a complex of corrective mechanisms for innovation: substantive and

technological constructs, based on foundation and visual modeling, adaptive regulation and self-regulation of activity, parameters of development of motivational, cognitive and social aspects of students, to learn how to present the results of comparative analysis of computational results, functional dependencies, calculation procedures, performed for the developed generalized constructof a complex mathematical knowledge in the common information and education environment, herewith the direct mathematical analysis can be carried out both in external programs of computer modeling and programming environments, and in the inner shell program.

Stage 4. Generalizing-transforming (reflection of the revealed internal conformities and the essence of mathematical objects and procedures)

At this stage, there is the transfer of the generalized mathematical model of the considered process or phenomenon, obtained at the third stage, to different areas of natural and humanitarian knowledge, where the systems under study are open and nonequilibrium with the realization of identification in the considered systems of all possible rapid changes, jumps, discontinuities, etc. Students find the real processes and phenomena of collective structures (focuses, boundary cycles, strange attractors, etc.) in the studied mathematical models with the help of bifurcation analysis that promotes creative searching, updating the motivation, and development of students' cognitive activity, in terms of synergy of mathematical education. The performance of applied scientific-research projectsby students implies the adaptation of the previously obtained full-fledged synergetic model to real processes and phenomena, through the prism of integration dialogue of mathematical, information, natural-science and humanitarian cultures, with the reflection of all necessary components, within the common information and education environment.

The main tasks of this stageare the following: to develop and to carry out the system analysis, using a synergetic approach, the real processes and phenomena, considered in the framework of various natural and humanitarian disciplines, from the perspective of a dialogue of mathematical, information, natural-science and humanitarian cultures, on the basis of the obtained at previous stages knowledge and skills of creation and all-round analysis of mathematical and information models, with the reflection of necessary components of scientific-research activity in the common information and education environment.

The common information and education environment for teaching mathematics with the use of synergetic approach

The implementation of the above four-stage process of teaching mathematics with the use of synergetic approach, within the framework of a dialogue of mathematical, information and various natural-science and humanitarian cultures, implies the performance of complex scientific-research projects by students of universities within small groups. For this purpose,the common information and education environment, developed by V.V. Bogun,whichis based on the remote system of dynamic calculation projects, previously developed by the author, can be used to reflect the necessary components of the activity. [5, 6].

The essence of each of the scientific-research projects, implemented by students, consists in multifaceted study of complex mathematical objects and processes, from the perspective of integration of the arbitrarily obtained components of the finite set of initially existing chaotic complex of knowledge and skills of students. It is done with the purpose of development the complex mathematical models of objects, with the possibility of creation of various systems with their unique properties, characteristics and principles.

Performed by the studentsscientific-research activity involves the separation of the initial group of students into small groups, for the investigation of a particular project theme. The distribution of social roles between students or very small groups of students is carried out within each group, depending on the peculiarities of students' thinking and character.

Within the framework of thecommon information and education environment, a single information space is envisaged, taking into account not only the main global attributes of students (names of universities, faculties, specialties or directions of bachelor's or master's programs, groups), but also internal local attributes of the scientific-research activities, described above, (attributes of students, schemes for grouping of students, outlining the students' roles within each small group, reflection of the performance parameters of scientific-research activity of every student for each of the four stages).Herewith all the components are represented as a multi-level system, taking into account the hierarchical structure.

In the information environment, the implementation of the following roles is envisaged. In accordance with them students perform certain types of activities to solvethe tasks, within the framework of achieving a specific goal of scientific-research activity:

1. The group "Managers" controls the process of performing the necessary tasks by all participants of a small subgroup. Within the information environment, it is possible to

consider the necessary components of scientific-research activity, implemented by students in their own virtual space, to communicate in the forums with the ability to download files of various types, both in private access between the group leader and a particular participant, and in public access between all members of the group.

2. The group "Analysts" defines the necessary functional dependencies within the framework of the performed scientific-research activities, carries out analytical analysis of mathematical models, etc. Within the information environment, it is possible to download files of various types, as well as to form the content of the participant's Internet page, and to display explicitly the necessary analytical components, using the formulas and additional multimedia components. For analysts, as well as for all participants of small group, there are opportunities for communication in the forums, with the ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all group members.

3. The group "Calculationalists" performscalculationprojects within the framework of remote system of dynamic calculation projects inside the common information and education environment, developed by V.V. Bogun. This group also performs calculation projectson the basis of algorithms, developed by the group of programmers, in accordance with the theme of scientific-research activities, carried out by the group, and aimed at students' realization of a comparative analysis of the results of calculations, functional dependencies, calculation procedures, performed as for the developed, as for the separate components, and the generalized construct of a complex mathematical knowledge. Within the framework of the information environment, participants of this group also have the opportunity to display the results of the research, both in the form of files of different types, loaded into the shell, and in the form of direct formation of the Internet page content,using multimedia. The calculationalists, as well as all participants of small group, have the opportunityto communicate in the forums with the ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all group members.

4. "Designers" group analyzes the mathematical model of a generalized construct of complex mathematical knowledge, developed by the group of analysts, with the purpose of construction ofvisual and functional information model;forms the scientific-research results in terms of obtained necessary functional dependencies, calculation procedures, dependencies between different values of initial data and the results obtained; carries out the analytical analysis of mathematical models, etc. in the framework of applied software of various

stationary and local information tools, in the form of computer mathematical systems. Herewith, the results are presented in the common information and education environment. Within the information environment, it is possible to download files of various types, with the results of the research of information model, as well as to form the content of the participant's Internet page, and to display explicitly the necessary analytical components, using the formulas and additional multimedia components. For designers, as well as for all participants of small group, there are opportunities for communication in the forums, with the ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all group members.

5. The group "Programmers" develops and tests the source codes of programs for algorithms, within the framework of visual programming environment, integrated in the information system, inherent both to individual components and the generalized construct of complex mathematical knowledge, presented in the form of mathematical model, in accordance with the theme of scientific-research activity, performed by the group. This is made with the purpose to further use of the program, for performing the comparative analysis of calculated results,functional dependencies, calculation procedures, by the students of other groups. It is also possible to export the files of the program source codes and related information, developed in external programming environments. In general, the algorithm for loading, processing and testing the source codes of programs is similar to loading the source codes of calculationprojects, in the framework of the remote system of dynamic calculation projects, developed by the author. For the programmers, as well as for all participants of small group, there are opportunities for communication in the forums, with the ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all members of the group.

6. The group "Communicators" searches for the processes and phenomena, within the framework of applied natural and human sciences, for which the developed generalized constructs of complex mathematical knowledge can be applied with the analysis of obtained models, through the prism of the dialogue of mathematical, information, natural-science and humanitarian cultures. Within the framework of information environment, the representatives of this group are provided with the possibility to download files of various types with the results of ongoing research, as well as to form the content of the participant's web page, displaying all necessary multimedia components. For communicators, as well as for all participants of small group, there are opportunities for communication in the forums,with the

ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all group members.

7. The group "Accomplishers" performs all the necessary work on the accomplishment of necessary components of reports on the scientific-research activity of the group, using various formats of visualization the necessary information (text and graphic files of documents, electronic presentations, interconnected Internet-pages, etc.), in the framework of the common information and education environment. For the accomplishers, as well as for all participants of small group, there are opportunities for communication in the forums, with the ability to download files of various types, both in closed access with the group leader and a particular member of the group, and in public access between all members of the group.

Thus, the common information and education environment, developed by the author, allows to organize a full-fledged scientific-research activity of students, in terms of dynamic web location, aimed at the comprehensive analysis of mathematical phenomena and processes, using a synergetic approach, within the framework of the dialogue of mathematical, information, natural-science and humanitarian cultures.

CONCLUSION

The realization of cognitive activity by students in the process of the study of various phenomena and processes,in terms of the use of synergetic approach, with the development and deep analysis of mathematical and information models, within the framework of the dialogue of mathematical, information, natural-science and humanitarian cultures, with the multifaceted use of both the information and communication technologies of computer modeling, and the common information and education environment, developed by V.V. Bogun, for the performance by the students of full-fledged scientific research activity, should be regarded as an integrative unity of personal qualities, fundamental mathematical training and the experience of the teacher, leading to the self-organization and self-development of students, from the point of view of mastering the multistage generalization of sign-symbolic systems of high level of abstraction, variety of mathematical knowledge.

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