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Development of Polytechnic Education in the Conditions of Integration of General-Engineering and Special Disciplines

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Abstract. In the conditions of innovative development of Polytechnic education and society in general in an educational paradigm there are basic changes. Today, the main units of updating of content of education are competence, the characteristic of their types and structure. Understanding students of existence of cross-disciplinary communications the importance of the studied disciplines in their interrelation and interaction is determined by cross-disciplinary competences.

In modern conditions, the role of geometric-graphic preparation is greatly expanded. The advantage is given to those professionals whose thinking is able to synthesize imaginative and rational. The development of the ability to such a synthesis is greatly facilitated by mastering the methods of geometric-graphic modeling of objects and processes. Let us emphasize that models based on geometric and graphical methods (with the ability to visualize the model) are often more effective in practice than purely analytical models. Therefore, the development of the theory of geometric modeling (with computer visualization) should not be considered in the narrow sense of geometric-graphic preparation, but as a self-valuable component of geometricgraphic education.

The author substantiates the essence of cross-disciplinary integration, presents the mechanisms of integration of disciplines at the Polytechnic University, pedagogical conditions, methods of teaching the theory of geometric-graphic modeling, as well as the results of practical implementation of theoretical provisions.

1. Introduction

The modern needs of improving the quality of Russian Polytechnic education pose the task of pedagogical science to determine the sources and directions of reforming engineering education. The integration of Sciences is of fundamental importance for the process of formation of professional competence of future engineers and for subsequent professional activities. Implementation of integration of disciplines in the educational process is determined by interdisciplinary competencies. The formation of interdisciplinary competencies ensures the subsequent effective professional activity of engineers, taking into account the rapid changes in the content of work and the updating of applied tasks. In such circumstances, the curricula should be based on the integration of education, science and industry.

2. Theoretical and methodological bases of integration of disciplines in the educational process of the Polytechnic University

Analysis of modern trends in the development of Polytechnic education has led to the conclusion that the basis of modernization of education should be a strategy that promotes the integrity of the percep-

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tion of the scientific picture of the world, systematic thinking, based on integration. Integration is the determining factor in updating the structure and content of education in the course of its Information. Moreover, the analysis of psychological, pedagogical and didactic-methodical literature devoted to the theory of integration showed the existence of different directions in the study of the essence of this phenomenon. If the integration of the content of education is considered as an object of research, then two main approaches can be distinguished: content and process approaches. In the first case, the aim is to create a system of generalized knowledge in students, in the second – a system of General activities for various disciplinary scientific fields.

As integrative mechanisms are taken the relationship and relationships that are established between the objects to be integrated according to the content structure and in a certain technological sequence, providing the movement of information and the influence of some components on others. As a psychological mechanism of integration, many researchers call the mechanism of associations, i.e. the purposeful formation of the necessary chain of associations in the students ' view, linking the concepts, theories, methods considered in different academic disciplines, into a single logically linked system of knowledge. It is known that if this chain of associations is absent, methods (as well as concepts and theories) become largely formal. Methods of science must be manifested in different contexts in order for these methods to be firmly and adequately assimilated by students.

The degree of integration interaction of disciplines is characterized by three levels. The first levelintersubject communications-at the solution of a problem of one subject knowledge from other discipline is involved. The second level – didactic synthesis-integration of educational subjects is carried out constantly on the basis of one of them, and each of the interacting subjects at the same time retains its status and its conceptual foundations. The third level-the integrity-culminating in the formation of a new discipline, which is integrative in nature and has its own subject of study. In this article, integration is studied at the second level. It is determined by the creation of a cross-disciplinary learning environment. A cross-disciplinary learning environment is integrity, which is created by the synthesis of scientific knowledge of disciplines and subjects of activity, associated with the exchange of ideas, methods, concepts and having properties that are not inherent in its disciplines. The creation of an cross-disciplinary environment is due to the fact that there are problems, the solution of which is based on the use of cross-disciplinary knowledge, using a complex method. This method concentrates the data of different Sciences about the object under study. This method is modeling. With this degree of integration, a new type of activity arises, the technologies of forming competencies change.

The basis for the implementation of integration in the educational process is its system-forming factors. The system-forming factor is an idea, phenomenon, concept, method, which are able to unite the components of the system into an integral unity; to establish the laws of content and structure necessary for organized, purposeful pedagogical influence on the formation of a new system with the given qualities; to maintain a certain and necessary degree of freedom of components; to ensure self-development and self-realization of the system. In scientific research, external and internal system-forming factors are distinguished. The content of external factors is determined by the requirements of practice, internal factors – the needs of the disciplines themselves. In the implementation of integration for the role of internal system-forming factors, we put forward, first of all, methods of geometric-graphic (visual-shaped) modeling, and the role of external factors – the use of applied methods of geometric-graphic modeling to solve engineering-geometric problems, causing the formation of cross-disciplinary competence.

It should be noted that the cross-disciplinary competences, in addition to knowledge, skills and abilities, include the following qualities of the individual: understanding the relationships between different disciplines and the willingness to apply knowledge from one discipline to the study of others; experience of complex application of knowledge in relevant disciplines in the study of others; the level of conscious application of knowledge in professional activities, based on the knowledge of different disciplines; confidence of the student in their ability to solve problems of professional activity, applying knowledge in various disciplines; willingness to study the discipline to gain new knowledge from other disciplines and activities; free orientation in the environment of information technology. IOP Conf. Series: Earth and Environmental Science 272 (2019) 032158 doi:10.1088/1755-1315/272/3/032158

Thus, the formation of the structure of the content of education in the Polytechnic University should be based on the integration of modern approaches. The author identifies such approaches as systemic, synergetic, competence, activity, information-cognitive, personality-centered, subject-scientific and research related to the specific subject of the study. As an integrative approach to the formation of the content of geometric-graphics education at the Polytechnic University, this study proposes a cross-disciplinary approach.

Cross-disciplinary integration allows students to build cognitive activity on the basis of General scientific ideas and methods. Cross-disciplinary integration is the process of formation of integrity associated with the exchange of ideas, concepts, methods, interpenetration of structural elements of different fields of scientific knowledge, leading to an increase in the capacity and concentration of knowledge, the expansion of its cognitive abilities. Cross-disciplinary integration is associated with the interpenetration of structural elements of different fields of knowledge and is accompanied by the growth of their generality and complexity, consolidation and organization. The formation of cross-disciplinary competencies is facilitated by the use of the method of geometric-graphic modeling (visual-figurative language) – an effective scientific method of knowledge, using computer graphics in teaching various disciplines. Moreover, geometric and graphic models have a universal interdisciplinary nature and arise in the training of almost any discipline.

3. Formation of the structure and content of geometric-graphics education at the Polytechnic University in terms of integration with general-engineering and special disciplines

Geometric-graphic disciplines (descriptive geometry and engineering graphics) are intended, at their core, to provide teaching of a number of courses at the Polytechnic University, as the intellectual activity of the engineer determines the operation with geometric-graphic visual images. The advantage is given to those specialists whose thinking is capable of synthesis of imaginative and rational. The development of the ability to such synthesis is greatly facilitated by mastering the methods of geometric modeling of objects and processes. Moreover, the student's deep mastery of methods and techniques of geometric-graphic modeling, manifested in the ability to build a complete chain of computer use (real situation, algorithm, visualization of the geometric-graphic model, analysis of results), reflects the essence of interdisciplinary content of education, providing natural integration of disciplines. Therefore, the development of the theory of geometric modeling with computer visualization should be considered not in the narrow sense of geometric-graphic training, but as a component of geometricgraphic education (GGE) in the General system of Polytechnic education. Thus, a new approach to the content of GGE is required, which transforms descriptive geometry (DG) into the theory of geometricgraphic modeling. This new approach is a cross-disciplinary approach - it is a tool of applied research that allows taking into account both the invariance of the content of education and its variability, manifested in a specific historical period by the requirements of professional activity.

The problem of implementation of cross-disciplinary integration contains a linguistic aspect. Introduction to the content of GGE ways to translate statements from one scientific language to another. One of these languages is the method of geometric modeling (visual-figurative language). It is known that human knowledge expressed in any written language can be divided into declarative (descriptive) and procedural (algorithmic, technological) knowledge. Declarative knowledge is not always possible in practice, but the same language, common to all scientific and academic disciplines, can be used to display the procedural knowledge applied in practice, allowing to Express any technological knowledge in any subject area. Thus, the implementation of the concept of interdisciplinary integration is based on the development of procedural knowledge. Moreover, mastering the general techniques of problem solving, allows you to generate methods of mental activities on the mastery of general patterns of action: assimilation and acceptance from the application transfer to a new situation.

Propositional networks and network models are taken as a basis for the modernization of the content of GGE. The General case of constructing these models is as follows. The nodes of a semantic network represent separate concepts (proposition) relations between nodes relations between concepts

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(proposition). In this approach, each concept (node) has a set of properties (characteristics, attributes). The function of some attributes is to establish different types of relationships with other nodes (proposition) of the semantic network. For example, for algorithmic geometric-graphic problems, the algorithm is used as a network (the connection between the source data and the result of the solution).

In the content DG the first problem is the problem of building a geometric-graphic model, which then solved the corresponding problems. To obtain a semantic network for building a geometricgraphic model or a network for solving problems, it is necessary to establish a relationship between the problem condition (source, data) and the desired (result of the solution). The problem of obtaining a semantic network includes two main stages: the construction of the network conditions of the problem (the component composition of the source data) and the construction of a set of relations connecting the network conditions with the network of the desired. The first of these steps contains the operation of creating a network of organized list of concepts, the second-the construction of a network of links between the available data and the desired properties that make up the solution of the problem. Moreover, the choice of a list of concepts plays an important role. The features of these concepts allow us to distinguish two types of concepts - sensory and categorical concepts. Of course DG categorical concepts are used, geometric sets are used. Functional characteristics (attributes) of these concepts is an algorithm that can be associated with any geometric set. The procedure for obtaining a geometricgraphic model of different dimensions and different structure is based on the construction of a propositional semantic network. For this purpose, a propositional variable (variable statement, proposition – "what", "than", "on what", "how") is set, which determines the main components of the geometricgraphic model, which, in turn, interpret the categorical concept. As a result, a semantic propositional network is built, leading to the corresponding design of the geometric-graphic model depending on the chosen categorical concept (set). The study [4] presents a systematization of all models studied in the course of DG on the propositional principle. The student who received the information in this form will be able to design any other models, replacing the components of this algorithm.

The solution of the problem of building a geometric-graphic model allows you to display various geometric shapes and solve algorithmic and heuristic problems on them. The basis of the categorical concepts systematization was the principle of the effectiveness of the logical conjunction operation of these concepts (geometric sets). This allowed us to set a hierarchical system of geometric sets on the basis of the same function performed by them. The author in his study [5] constructed a semantic network for solving geometric-graphic problems, based on the systematization of categorical concepts in DG.

4. Conclusion

The article proposes one of the ways of development of Polytechnic education. This way of development is realized by the integration of geometric-graphic, General engineering and special disciplines. The system-forming factor of integration is the geometric-graphic model (visual-figurative language). The methodological basis of integration is an interdisciplinary approach. The interdisciplinary approach is based on the integration of fundamental and variable components, which determines the interdisciplinary component. The fundamental component is based on the content of geometric-graphic knowledge, the core of which is the geometric-graphic modeling. The variable component is based on the content of geometric and graphic knowledge aimed at the professionalization of graduates of the Polytechnic University in their chosen specialty. The interdisciplinary component is a structurally organized form of interaction between the fundamental and variable components, United by one goal. The goal is to realize the professional qualities of the individual and leads to the development of interdisciplinary competence of future specialists.

Thus, descriptive geometry as a theoretical and methodological component of geometric-graphic education should be transformed into the theory of geometric-graphic modeling. Such transformation should be based on an interdisciplinary approach. The mechanism of implementation of an interdisciplinary approach to geometric and graphic education in the context of integration of disciplines at the Polytechnic University includes content and technological aspects. The content aspect is determined International science and technology conference "Earth science"

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by the integration of fundamental and variable components, which determines the interdisciplinary component of the geometric and graphic knowledge in the training of specialists in a particular technical direction. The technological aspect is a variable use of forms, methods and means of teaching students based on the features of geometric and graphic education. On the basis of the interdisciplinary concept of geometric and graphic education in the Polytechnic University is determined by the model of a specialist technical direction, its content component, which is designed educational process.

5. References

- [1] Bezrukova V S 1994 Integration processes in pedagogical theory and practice Ekaterinburg p 152
- [2] Berulava M N 1993 Integration of educational content Moscow, Pedagogy p 172
- Budanov V G 2007 methodology of synergetic in post-non-classical science and education M.: LKI p 169
- [4] Shangina E I 2010 Methodological bases of formation of the structure and content of geometricgraphic education in a technical University in terms of integration with General-engineering and special disciplines Diss. Doctor of (Full) Sc: Moscow
- [5] Shangina E I 2007 The semantic model for solving geometric tasks. News of higher educational institutions **2** Yekaterinburg: *UrSMU* pp 151-160