INTERDISCIPLINARY INTEGRATION AS A CONDITION FOR THE MODERNIZATION OF TEACHER EDUCATION

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Abstract

The modern educational trend is aimed at the introduction of information technology tools in the educational process of universities. In this regard, important in the teaching of the students are the matters of integrating education in mathematics and information technology. The relationship between mathematics and informatics is based on the content of these subjects. Modern resources of information technology can effectively solve mathematical problems. At the same time, the content of the course of higher mathematics determines the nature of the material studied in computer disciplines, since they can use knowledge from all sections of mathematics.

Methodology related to the implementation of integrated project assignments oriented to the practical application of the acquired knowledge in the disciplines "Mathematical Analysis", "Computer Modeling" and "Programming" is offered in the article. The examples of the certain integrated project tasks are presented.

The introduction of this methodology is recommended in connection with the current level of development of computer science and mathematics. The creation and development of methodology which is based on the systematic use of information technology is a necessary and timely step towards increasing the effectiveness of mathematical education.

Keywords: integrated project tasks, mathematical analysis, computer modeling, programming.

1 INTRODUCTION

The modern educational trend is aimed at the introduction of information technology tools in the educational process of universities, hence the matters of integrating education in mathematics and information technology are important in the teaching of the students.

The article deals with the training of bachelors related to the integration of teaching mathematics and information technology. The relationship between mathematics and informatics is based on the content of these subjects. Modern resources of information technology can effectively solve mathematical problems. At the same time, the content of the course of higher mathematics determines the nature of the material studied in computer disciplines, since they can use knowledge from all sections of mathematics.

A considerable number of research papers have been devoted to the study of the integration of mathematics and computer science: I.N. Polunina [7], G.L. Lukankin [4], A.N. Pavlova [6], L.N. Vasilyeva, N.I. Merlina, N.I. Svetlova [5], V.M. Fedoseev [9] and others.

Computer mathematics systems as a way to achieve a high level of meta-subjective relationships are considered by M.Y. Denisova [3], V.V. Solonin [8], R. Ziatdinov, V. Rakuta [14]. The research of T.Yu. Gainutdinova, M.Yu. Denisova, O.A. Shirokova [1,2,10-13] is devoted to systematic use of systems of dynamic geometry and software environments in the process of teaching students in higher mathematics.

2 METHODOLOGY

One of the problems of the creating deep and stable system of knowledge and skills in students in the process of teaching higher mathematics is the fragmented knowledge of the basic level in this discipline. Utilization of capabilities of information technology for calculating and visualizing mathematical models in the process of teaching higher mathematics is suggested to solve this problem. On the other hand, it is necessary to develop practical skills and applications of computer modeling of the investigated objects using mathematical packages of applied programs and software environments.
Based on the analysis of existing integrated learning technologies, a method related to the implementation of integrated project assignments oriented to the practical application of the acquired knowledge in the disciplines "Mathematical Analysis", "Computer Modeling" and "Programming" seems effective. Integrated project assignments should contribute to the creation of professional and mathematical competence of students. Thus, the learning tool in the form of an integrated project task is the link between mathematics and informatics. Selecting assignments, first of all, we have to proceed from the needs of the taught disciplines, and assignments for every project should be sufficiently rich, meaningful and consistent with the curriculum.

3 RESULTS

The integrated project assignments can consist of the following sections: visualization of the derivative; the problem of finding the maximum and minimum of the function; integral sums of Darboux; multiple integration; finding areas and volumes.

The process of the execution of the assignment consists of the following stages:

- construction of a mathematical model;
- examination of the constructed model using methods and tools of mathematics and information technologies which are based on the use of computer mathematics and high-level languages C++, C#, Delphi;
- geometric construction of the research model and its dynamic visualization using systems of computer mathematics;
- testing the obtained results of the project, verification of the results of mathematical research, variation of conditions;
- formalizing and summarizing results of research;
- evaluation and defense of the project.

Let us consider some examples of problems from project assignments on finding the maximum and minimum of a function.

Find the height h of the cone with the largest volume, which can be inscribed in a sphere of radius R. Imagine a mathematical model: denote h as the height of the cone, then the radius of the base is \( r = \sqrt{2Rh - h^2} \), therefore the volume of the cone is

\[
V = \frac{1}{3}\pi(2Rh^2 - h^3)
\]

Solving the problem analytically, we obtain the following result: the height of the cone is \( h = \frac{4R}{3} \).

Following the steps of the project assignment execution, the result obtained analytically must be examine using the computer mathematics system Maple (Fig. 1, 2).

![Figure 1. The relationship between the volume of a cone and its height.](image)
At the same step, it is recommended to present the extremum of the function and build its graph using one of the high-level languages: C++, C#, Delphi.

The next step of the implementation of the assignment is the geometric construction of the research model and its dynamic visualization using the system of computer mathematics - Maple. For this, it is necessary to develop a procedure linking the volume to the height of the cone. The developed procedure (Fig.3.) is used to create a dynamic visualization (Fig. 4, 5).
At the stage of analyzing the obtained results, it is possible to vary the conditions for the input parameters, for example, such as the radius of the ball. Conduct a comparative analysis of modeling methods in the systems of computer mathematics and software environments. The remaining sections of the integrated project assignment are studied similarly.

When evaluating the results of an integrated project, one should take into consideration: the accuracy of the mathematical model and its implementation; the effectiveness of the use of information technology, which include research in computer mathematics systems and software environments with dynamic visualization.

The development of a methodology which is based on integrated project assignments oriented to the practical application of the acquired knowledge in the disciplines "Mathematical Analysis", "Computer Modeling" and "Programming", requires the coordination of the content of the projects with the learning objectives.

The curricula of the bachelor students should include integrated project assignments on a regular basis, and they should become a planned type of study: with the scheduled hours and methodological support.

The methodology for compiling integrated project assignments reflects, on the one hand, the content and methodology of teaching mathematics and computer science, and on the other hand, the needs and objectives of studying courses.

The results of the application of this methodology showed that:

- Integrated project assignments which use information technologies, contribute to increased level of mastering the material of complex sections of higher mathematics,
the content of the course of higher mathematics is the fundamental basis of the material studied in computer disciplines, and therefore contributes to its deep understanding;

computer mathematics systems allow the research of studied objects, visualization of which facilitates the solution of the tasks, not only they visualize the given objects, but also show them in dynamics;

integrated project assignments form practical skills of applying computer modeling using programming in various software environments;

a methodology based on meta-subject relationships of disciplines, contributes to the development of students' interest in the study process;

the implementation of integrated project assignments develops research capabilities and forms the research ability of future teachers of mathematics and computer science.

4 CONCLUSIONS

The construction of mathematical education on the basis of the integration of mathematics and computer science makes it possible in a new way to form the abilities of students in pedagogical track to solve relevant, professionally important tasks, encourages to be initiative, independent, and as a result it gives rise to the ability to produce productive research activities.

The use of research activities and integrated project assignments in modern education is determined by their multifunctional focus, as well as the possibility of integrating into a holistic educational process, during which the basic knowledge and core competencies of students are formed.

The integrated project assignments contribute to the development of the skills to use the mathematical apparatus in professional-mathematical activity and thereby form the research competences of future teachers of Mathematics and Computer Science.

The introduction of this methodology is recommended in connection with the current level of development of computer science and mathematics. The creation and development of methodology which is based on the systematic use of information technology is a necessary and timely step towards increasing the effectiveness of mathematical education.

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