**UDC 378:004**

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# *REALIZATION OF INTERDISCIPLINARY COMMUNICATIONS OF FUNDAMENTAL DISCIPLINES AND DISCIPLINES OF MATHEMATICAL CYCLE IN THE PREPARATION OF FUTURE PROGRAMMERS*

DOI: 10.14308/ite000570

*The article is devoted to interdisciplinary communication in the process of preparation of the future programmers and implementation of the basic principles of these relations in the study of disciplines of professional and practical training and math courses. The article deals with the role of interdisciplinary connections, as well as their function and significance for the formation of cognitive activity, independence and positive learning motivation. The focus is on methodological aspects of realization of interdisciplinary communications at studying basic disciplines of training future programmers and disciplines of mathematical cycle. In particular, the issues of realization of interdisciplinary communications during the study such disciplines as "Computer graphics, computational geometry," "Basics of algorithms and programming", "Programming Technologies" and the course "Analytical geometry and linear algebra", which included in to normative part of the training of programmers. This article describes the theoretical aspects of the implementation of interdisciplinary connections in the study of these disciplines, as well as examples of practical tasks with which these relationships can be implemented most effectively during training.*

***Keywords:*** *interdisciplinary communication, training of future programmers.*

**Introduction.** One of the major challenges of high school at the present stage is to prepare competent and proactive professionals, who possess basic training and are able to independently develop new skills and acquire new technologies. Graduates from all areas of training, including technical, should be able to analyze the processes occurring in their professional activities, and solve related production problems. This modernization of education in higher school due to the transition to the level-education. Under the new standards, most of classroom time is devoted to independent work of students, and therefore reduces the number of classroom hours to study disciplines [3,4]. As a rule, training of programmers now provides them the fundamental knowledge related to their future professional activity. However, special knowledge gained in the study courses of professional module provides only a portion of a specific activity. Working in any field, man is forced to respond to the changes that are constantly taking place in it, using the entire stock of theoretical knowledge. The basis of the theoretical framework is fundamental knowledge, that he receives not only the study of professional disciplines of the module, but also in the study of the natural sciences, particularly mathematics. Thus, there is a contradiction between the increasing quality requirements for fundamental education of future programmers and reduction of class hours, that are assigned to the study of mathematics and other general subjects. This contradiction can be solved by using methodological approaches of teaching, which is based on interdisciplinary communications.

**The role of interdisciplinary communications in the learning process.** In the education interdisciplinary communications – is a way of formation of practical skills and abilities to apply knowledge from one discipline in the study of the other. Formation of the fundamental knowledge, that meet the objectives of training, it is impossible without the use of arbitrary or involuntary methods of forming interdisciplinary connections. Fundamental knowledge

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characterized by a variety of internal and external relations, reveals the structure of the content and define the methodological basis of a particular subject area, and their main characteristics are the stability, sustainability, universality and accessibility. Subject knowledge are considered as part of the general system of knowledge [6].

The problem of interdisciplinary relationship is the subject of many scientific and educational researches (J.K. Babanskii [1], P.A. Burdin [2], I.D. Zverev [24], V.N. Janzen, J.S. Brodsky, P.G. Kulagin [8] and others) and of numerous dissertations. The need to use the interdisciplinary connections in the learning process, psychological patterns, that underlie their implementation, are reflected in the works of N.A. Menchinskaya, Y.A. Samarin and others. Many teachers and methodologists point out, that the problem of development of interdisciplinary connections in high school need to be addressed, as in the universities there exists an isolated study of the various disciplines cycles and use the knowledge gained in their professional activities. A special case of the principle of interdisciplinary connections in high school is the use in the study of general disciplines applied problems. Various aspects of this problem are discussed in works of G.L. Lukankin, V.M. Monakhov, G.I. Sarantsev [22] and others. They deal with or a general pedagogical aspects of vocational training of students of technical colleges, or the implementation of the principle of interdisciplinary connections through the construction of applications and exercises.

The problem of effective implementation of interdisciplinary relationship in higher education is relevant, as these communications are combined in a single unit all the structural elements of the learning process (content, forms, methods and means of training) and enhances its effectiveness. This issue is carried out by tasks such as:

- analysis programs to identify courses of parallel and successive presentation of the [5];
- identification of the courses, the use of integrated approaches, that would be most effective [5];
- identification of relevant professional skills of students and building a system of interdisciplinary problems for their formation [7];
- the formulation of criteria for the implementation of successive interdisciplinary connections during classroom and on their basis to develop the content and methodology of integrated lectures and workshops [5].

Realization of interdisciplinary communications helps shape students' understanding of the whole phenomena and the relationship between them. This makes educational achievement is almost more important, helps to use in the study of some subjects the knowledge and skills, that students have acquired in the study of other, makes it possible to solve problems in specific situations, when considering particular issues, both in training and in the future work. The role of interdisciplinary connections increases due to the increased amount of information to be learned, and increase the proportion of independent work of students in high school training.

Using interdisciplinary connections in learning encourages students to professional improvement. With the help of multilateral interdisciplinary relationship not only solved the problem of education and development of students to a qualitatively new level, but also lays the foundation for a comprehensive solution of complex problems of reality. Given the interdisciplinary communication can be achieved:

- agreed at the time to study different subject disciplines for the purpose of mutual support;
- grounded consistency in the formation of concepts;
- uniqueness of requirements for knowledge, skills and abilities;
- the use of certain disciplines in the study of the knowledge gained in the study of the other;
- the elimination of unnecessary duplication in the content items;
- demonstration of community methods used in the study of processes and phenomena in different disciplines;

- prepare students to master modern technologies.

Realization of interdisciplinary communications of mathematical and fundamental disciplines in the preparation of future programmers. Mathematics is part of the training of the future programmer, so math teachers should be aware of the content of general and special disciplines to understand what mathematical knowledge is particularly necessary to those skilled in the sector of higher education. This will help to bring together the teaching of mathematics with the requirements of the practice, improve the system of mathematical and as a result, training and courses to fill such examples and problems to be the most similar and interesting students as future professionals. In this regard, the urgency is the problem of organic combination of professional and fundamental education, which is carried out through the establishment of inter-subject relationship with the fundamental disciplines of mathematics.

The problem of the level and content of mathematics education programmers is one of the most talked about in academic circles and among the programming community. She was the subject of numerous scientific and methodological publications (e.g. [10-14]) and discussions on internet forums. The extreme points of view are as follows:

- The programmer does not need math, in fact – and the special higher education too.
- Programming, in fact – specific mathematical operations, so the programmer must have both fundamental (general) mathematical training in the amount of classical university course, and explore the many special sections of computer mathematics.
- Programming, in fact – specific engineering activities, so the programmer must have a common mathematical training in the amount of engineering high school, general engineering training, and explore the many special sections Computer Engineering.

A balanced and well-designed point of view in the form of guidelines for the design of curricula level "bachelor" for specialty "computer" and "software engineering" of universities is presented in [9] (in this article – CC "Computing Curricula"). This book is essentially an international standard defines the actual content of programmers. It is isolated minimum necessary fundamental nucleus of programmers, including both mathematical knowledge, as well as special fundamental and applied knowledge of computer science and its adjacent sections. Information is thus defined as an independent field of knowledge cannot be reduced either to mathematics or to the amount of other scientific knowledge.

Equally important for us is the practice of formation curricula of these specialties in Ukrainian universities. Specialty programming (departments) Ukrainian universities are outdoor swimming, or on the basis of mathematical faculties of classical universities (KNU Taras Shevchenko, KNU Karazina, etc.), or on the basis of the engineering faculties of universities (KNTU "KPI", HNTU LNTU "Lviv politehnika", "KPI", etc.). Therefore mathematical training of programmers originally (the sixties – seventies of the 20th century) was either classical or engineering. Currently, these two lines are slowly converging to the SS, aided by the recently adopted state standard bachelor in "computer science", keeping this difference of inertia.

In CC, specialty "Software Engineering" contains 10 areas of knowledge, only one of which is dedicated to mathematics. For the purposes of this article the important role played by the content of this field of study, called the SS "Fundamentals of mathematics and engineering." The first 11 units of knowledge (topics) define the core of mathematical preparation of the programmer (see. table of paragraph 4.9, p. 42).

Note the following circumstances: on the CC, the study of continuous mathematics (mathematical and functional analysis, differential equations, mathematical physics, continuous probability theory, control theory, etc.) is not included in the core content of compulsory training programmers. Core contains the algebra and number theory, mathematical logic, discrete mathematics, discrete probability theory, theory of errors. However, it is a continuous math on the number of hours takes place on the main mathematical faculties of universities, and the engineering faculties of technical universities. Ukrainian universities essentially train specialists in mathematical modeling, mathematical and computer software, information technology.

This is because the mathematical foundations of software engineering provides theoretical and scientific basis for the development of software products with the desired properties. This framework helps to give an accurate description of the products of software engineering. They are mathematical methods to model and allow you to make an inference about the products and their relationships, as well as provide a basis for predictable design process. Thus, the connection of mathematics with subspecialties allows to provide a better assimilation of knowledge, forms and skills that will help future programmers to solve problems related to their professional activities.

The most common form of manifestation of interdisciplinary communications of mathematics are professional and applied orientation of training now. Note also, that the effective reception of the complex interdisciplinary communication are: coordination of programs of training courses "Mathematics" and "Informatics"; cross-curricular texts – methodological developments for students interdisciplinary nature; complex interdisciplinary projects for independent work on the basis of inter-subject texts. If the decision of applied problems in the course of mathematics to complement the implementation by software (setting the multilateral relations "Mathematics - Computer Science"), the principle of training related to the preparation for the future professional activity, receive a logical development in today's information society. If a coordinated program of mathematics and computer science, the process of implementation of mathematical models on the computer going consolidation of mathematical skills. Using the software for solving mathematical problems, not only during laboratory work in disciplines of the course of computer science, but also in carrying out independent examinations and practical training in mathematics, allows you to move the center of gravity with computational operations on the qualitative aspect of the problem, and as a consequence, increase the productivity of cognitive activity of students.

Consider the examples of interdisciplinary connections of analytical geometry and linear algebra (AG & LA) and basic disciplines in the preparation of future programming.

*Realization of interdisciplinary communications of disciplines "Computer graphics, computational geometry" and "*Analytical geometry and linear *algebra"*

Interdisciplinary communication between these disciplines are systemic. As such, AG&LA – mathematical basis of three-dimensional objects imaging algorithms. Pay attention to the following properties:

1. The movement of a point in three-dimensional space is described in terms of the primitive group of motions of parallel transport, Rotate, Stretch. Displays points on the plane of the screen describes the operation of projection.

2. All these transformations are reduced in 4-dimensional space to a uniform linear matrix-vector multiplication and subsequent normalization result. Therefore, the operation matrix-vector multiplication can be parallelized and implemented in hardware in the graphics coprocessor.

3. To describe the motion of the body 3-dimensional vector graphics need to cover the surface of the frame triangles rather small – i.e. solve the problem of triangulation. The movement of the body then is reduced to the amount of motion of the nodes of triangulation.

4. In solving problems displaying mutual arrangement of bodies and other problems of computational geometry used such basic tasks of hypertension, such as the problem of intersection of the plane and planes in space. Note that in the course of classical AG&LA uniform vector spaces at best only mentioned.

Given our analysis, we can recommend the teaching of the relevant topics of the course AG&LA for programmers to build a search for a common solution of the problem of visualization of the moving body in the window screen. For example, one of the objectives of this approach can be formulated as follows:

*Problem* 1. On the coordinate plane are segments *AB*, *CD*. To determine whether they overlap and to find their intersection point *M*.

*Realization of interdisciplinary communications* of *disciplines "Basics of algorithms and programming" and "*Analytical geometry and linear *algebra"*

In mathematical disciplines algorithms occupy a prominent position. At the same time, the algorithms are at the heart of programming and are the subject of special study in computer science. The approaches to the study of algorithms in mathematics and computer science courses there is a mismatch, based in particular on the fact that in mathematics an algorithm – an effective process, and in computer science – writing process, business model. In the course of informatics the algorithmization considered as the process of obtaining and formal description of the algorithm in any algorithmic language. Because the algorithm is executed in computer related software products, in teaching algorithmization focuses on the process of a formal description of the algorithm. In the course of mathematics on the contrary "syntax" side of the studied algorithms and a clear description of their structure are presented slightly, the focus is on the creation and implementation of algorithms. With a view to harmonization and convergence of approaches to the study of algorithms in computer science and mathematics courses for training future programmers important it is to strengthen the "syntax" side of the studied algorithms in the process of teaching mathematics, which will help the students realize their own methods of work in the process of solving mathematical problems.

In addition, the traditional practice of teaching problem solving using computer technology in the course of computer is that the focus is on the construction of algorithms and translating them into the language of programming. However, this process is much wider and is a technological chain, which includes the statement of the problem, model creation, development of algorithms, writing programs to develop an algorithm testing program. The success of the solution of the problem depends on how faithfully carried out all the actions that are part of this process chain. As the professional activities of future programmers provides a solution mainly applications, particularly important to focus on building models. Due to the fact that most of the models are mathematical, construction of solutions applications relies heavily on mathematics. In this regard, the training of future programmers is urgent strengthening of the model dimension in the process of learning the disciplines of mathematical cycle that will create in students a better idea about the entire process chain solving problems and will significantly change students' attitudes towards mathematics, will make their learning activities more meaningful and productive. The basis of interdisciplinary connections on "algorithms" and "programming" make the types of problems for which the algorithm of the program or created. Algorithms for computing functions allow for increased understanding of the concept of a mathematical function. The theme of "programming" can develop some ideas of numerical methods, formed in the course of mathematics.

Training course material AG & LA is a very good subject area for the course bases of algoritmization and programming (BAP). In particular, some of those labs Course CAP whole or in part can be built on the material of AG&LA. This topics are *Data Type Real*, *Arrays and the operator of cycle with parameter*, *procedures and functions.* As examples, we can consider the problem of tasks such as:

*Problem* 2. In a 3-dimensional space are: a plane and a point. Find the base of the perpendicular from a given point on this plane.

*Problem 3.* Create a program matrix-vector multiplication.

*Problem 4.* The triangle *ABC* given the coordinates of its vertices. Write a program to compute the distance between the centres of the inscribed and circumscribed circles in the triangle. The program should use the procedures and functions of the basic problems of hypertension.

This approach is implemented in [ ].

The course "Algorithms and Data Structures" is a fundamental discipline that continues algorithmic training programmers. One of the fundamental concepts of the course is *Abstract types of data and structures of data* (ATD and SD). A good elementary subject area, which we recommend as an example, is construction with a ruler and dividers. For example, consider the following algorithm for solving the problem of building:

*Problem* 5. Formulate algorithm for bisection of the interval with a ruler and dividers. Formulate ATD "Geometric constructions". To realize his SD.

*Decision*: Midpoint algorithm;

*Login*: points *A, B* – the ends of the segment *AB*;

*Exit*: Point E – the midpoint of AB.

Construct a circle $O_1$ with the centre *A* and radius *AB*;
Construct a circle $O_2$ with centre B and radius *AB*;
Find points *C* and *D* the intersection of circles $O_1$ and $O_2$;
Build line $l_1$ through the points *C, D*;
Build line $l_2$ through the points *A, B*;
Find point *E* of intersection of $l_1$, $l_2$.

ATD "*Geometric constructions*".

Build segment *s* with endpoints *A, B*:

*Login*: points *A* and *B*.

*Exit*: segment s with ends in points *A, B*.

*Build* line *l* through points *A, B*:

*Login*: points *A* and *B*.

*Exit*: line *l*, which passes through the points *A, B*.

Construct a circle *O* with the centre *A* and the radius *BC*:

*Login*: points *A, B, C*.

*Exit*: circle *O* with centre *A* and radius *BC*.

Find the point of intersection of $l_1$ and $l_2$:

*Login*: lines $l_1$, $l_2$.

*Exit*: point *A* of intersection of lines $l_1$ and $l_2$.

Find the points *A* and *B* of intersection of circle *O* and the line *l*;

*Login*: circle $_O$, line $_l$.

*Exit*: points $_A$ and $_B$ of intersection of circle *O* and line *l*.

Find the points $_A$ and $_B$ of intersection of circles $O_1$ and $O_2$;

*Login*: circles $O_1$, $O_2$.

*Exit*: points *A* and *B* of intersection of circles $O_1$ and $O_2$.

Primitive data types:

Point (*Point*), Line (*straight line*), Circle (*circle*).

The base primitive type: Boolean.

Primitive operations:

Line: (Point, Point) → Line

*l = Line(A, B)* direct line l, which passes through the points *A, B*

Circle: (Point, Point) → Circle

*o* = Circle(*A, B*) direct circle o with centre *A*, which passes through the point *B*.

CircleRad: (Point, Point, Point) → Circle

*o* = CircleRad(*A, B, C*) direct circle o with centre A, dividers built solution with legs set out in *B, C*.

IntersectLines(Line, Line) → Point

*A* = Intersect(*l, m*) direct point of intersection of lines *l* and *m*

IntersectCircles(Circle, Circle) → (Point, Point)

*(A, B)* = IntersectCircles(*o, p*) direct points *A, B* of intersection of circles *o* and *p*.

IntersectLineCircle(Line, Circle) → (Point, Point)

*(A, B)* = IntersectLineCircle(*l, o*) direct points *A, B* of intersection line *l* and circle *o*.

From primitive object types ATD Plant Geometry can build so called composite types now. For example, a type of triangle can be defined as three points – the vertices of the triangle.

*Triangle* = (point, point, point)

From primitive (basic) operations ATD can define derivatives transaction. For example, the operation

ParralelLine: (point, line) → line,

the result of which is a straight line, passing through a given point and parallel to a given line can be determined through primitive operations, and then used in the algorithms for solving problems in the construction. Realization (interpretation) ATD can do separately using data structures, and elementary operations defined in AG&LA.

*Realization of interdisciplinary communications of disciplines "Analytic geometry and linear algebra" and "Technologies of programming"*

In the basic and advanced courses of Technologies of programming AG&LA serves as one of the subject areas.

*Object-oriented programming*. Implementation of analytical geometry objects - a good example of object-oriented programming (OOP). The task of building domain AG can be offered as one of the primary examples of how the lectures of the PLO, and in one of the labs at the rate of the PLO. In the spotlight is the class hierarchy AG, as well as clarify the primitive operations domain as a class method.

*The algebraic programming*. Linear algebra (vector spaces, algebra) is a classic example of a low-grade algebraic system. Therefore, one of the objectives of the course algebraic programming is a task the implementation of a vector space. Basic operations of this algebra – addition and subtraction of vectors, multiplication of a vector by a member of the base field [15, 16]. This algebra can be extended to algebra of Euclidean vector spaces by introduction the scalar product and the norm (length) of the vector [15]. Further expansion is due the introduction of a system of linear operators and display the vector space operations. This task is recommended to offer as through laboratory work on the course of algebraic programming, and its expansion as a standalone application – as the exchange course and the final work.

*Realization of interdisciplinary communications of discipline "Analytic geometry and linear algebra" and diploma projects*

Modern technologies of training involve the active implementation in the educational process information and communication technologies (ICT). From our point of view, the use of ICT in the learning process – one of the most promising and rapidly developing subject areas. In connection with this is urgent subjects of diploma works is actually in the subject area. In particular, as a graduation project for a group of students can propose the development of a mathematical system to support distance learning course AG&LA, which involves the active use of computer algebra methods and techniques of algebraic programming. With the concept and details of systems of this type can be found in [10-12].

Conclusion. Given the fact, that the mathematical foundations of software engineering provides a theoretical basis for the development of software products, the relationship of mathematics with subspecialties allows to provide a more complete assimilation of knowledge, but also allows you to create and skills, that will help solve problems related to occupational. Interdisciplinary communications of fundamental disciplines and disciplines of mathematical cycle in the learning process of future programmers are, on the one hand, as a pedagogical category, which is used to describe the integrative relationships between different objects, phenomena and processes of reality and, on the other hand, as a general pedagogical phenomenon, which has a direct impact on all the components of their training. Along with education and educational function of interdisciplinary communication perform another important function – to develop. They serve not only the means of forming a flexible and efficient system of knowledge, but also the generalized methods of action. Exactly interdisciplinary communications contribute to a more productive form of cognitive activity and independence in the development of cognitive interests and positive learning motivation.

Realization of interdisciplinary communications of fundamental disciplines and disciplines of mathematical cycle in the learning process of future programmers can be carried out using:

- consistency of the programs of training courses "Mathematics" and "Informatics";
- additions solve applied problems in mathematics courses of the implementation with the software;

- strengthening aspects of the model in the study of mathematical disciplines cycle;
- implementation of complex interdisciplinary projects students during independent work, in particular, the development of a mathematical system support remote examination of the mathematical course.

During training, based on interdisciplinary communications, develop generalized intellectual skills that characterize certain activities, that are common to a number of subjects. Interdisciplinary communications stimulate the development of creative activity (the ability to carry on their own knowledge and skills in a new situation, a new ability to see the problem in a familiar situation, the ability to establish new properties of the object of study, etc.).

The use of interdisciplinary communications should not be an end in itself, but only help in solving the problems in education. Optimal using of interdisciplinary communications not only to discover the essence of the studied subjects, but also to show its practical significance, the relationship with other disciplines, which allows to shape the learning process systematized, generalized professional knowledge required for the future of skilled programmers.

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Стаття надійшла до редакції 11.02.16

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**РЕАЛІЗАЦІЯ МІЖПРЕДМЕТНИХ ЗВ'ЯЗКІВ ФУНДАМЕНТАЛЬНИХ ДИСЦИПЛІН ТА ДИСЦИПЛІН МАТЕМАТИЧНОГО ЦИКЛУ В ПРОЦЕСІ ПІДГОТОВКИ МАЙБУТНІХ ПРОГРАМІСТІВ**

Стаття присвячена міжпредметним зв'язкам в процесі підготовки майбутніх програмістів та основним принципам реалізації цих зв'язків при вивченні дисциплін професійної та практичної підготовки та математичних курсів. В статті розкривається роль міжпредметних зв'язків, а також їх функції та значення для формування пізнавальної активності, самостійності та позитивної мотивації навчання. Основна увага приділяється методичним аспектам реалізації міжпредметних зв'язків при вивченні базових дисциплін підготовки майбутніх програмістів та дисциплін математичного циклу. Зокрема, розкриваються питання реалізації міжпредметних зв'язків при вивченні таких дисциплін, як "Комп'ютерна графіка, обчислювальна геометрія", "Основи алгоритмізації та програмування", "Технології програмування" та дисципліни "Аналітична геометрія та лінійна алгебра", що входить до нормативної частини підготовки майбутніх програмістів. Стаття містить як теоретичні аспекти реалізації міжпредметних зв'язків при вивченні вказаних дисциплін, так і приклади практичних завдань, за допомогою яких ці зв'язки можуть бути реалізовані в процесі навчання найбільш ефективно.

**Ключові слова:** міжпредметні зв'язки, підготовка майбутніх програмістів.

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**РЕАЛИЗАЦИЯ МЕЖПРЕДМЕТНЫХ СВЯЗЕЙ ФУНДАМЕНТАЛЬНЫХ ДИСЦИПЛИН И ДИСЦИПЛИН МАТЕМАТИЧЕСКОГО ЦИКЛА В ПРОЦЕССЕ ПОДГОТОВКИ БУДУЩИХ ПРОГРАММИСТОВ**

Статья посвящена междпредметным связям в процессе подготовки будущих программистов и основным принципам реализации этих связей при изучении дисциплин профессиональной и практической подготовки и математических курсов. В статье

раскрывается роль межпредметных связей, а также их функции и значение для формирования познавательной активности, самостоятельности и положительной мотивации учения. Основное внимание уделяется методическим аспектам реализации межпредметных связей при изучении базовых дисциплин подготовки будущих программистов и дисциплин математического цикла. В частности, рассматриваются вопросы реализации межпредметных связей при изучении таких дисциплин, как "Компьютерная графика, вычислительная геометрия", "Основы алгоритмизации и программирования", "Технологии программирования" и дисциплины "Аналитическая геометрия и линейная алгебра", которая входит в нормативную часть подготовки программистов. В статье содержатся как теоретические аспекты реализации межпредметных связей при изучении указанных дисциплин, так и примеры практических заданий, с помощью которых эти связи могут быть реализованы в процессе обучения наиболее эффективно.

**Ключевые слова:** межпредметные связи, подготовка будущих программистов.