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THE STRUCTURE AND CONTENT OF TEACHING HIGH SCHOOL STUDENTS AL-FARABI TRIGONOMETRY, FOCUSED ON THE DEVELOPMENT OF THEIR COMPUTATIONAL THINKING

Abstract

The trigonometric heritage of al-Farabi, the great thinker of the Middle Ages, who made an invaluable contribution to the development of world science and civilization, is of enormous theoretical and practical value. It offers unique algorithms for finding the sin 1 degrees and constructing trigonometric tables necessary for solving various practice problems. Their inclusion in modern computer and mathematical education will not only popularize the legacy of the great scientist, but will also enrich the content of teaching trigonometry, strengthening its applied orientation, expand the system of subject knowledge of students, and contribute to the development of skills that determine the essence of computational thinking, which is one of the important goals of modern education. Al-Farabi's trigonometry training should be focused on achieving the specified results. Adequate to the goals and objectives of teaching al-Farabi trigonometry to schoolchildren, it is advisable to determine its subject-thematic content. Purpose of the study: to determine the structure and content of teaching al-Farabi trigonometry, aimed at developing students' computational thinking skills. Results: the basic principles and methods for selecting content are determined, on the basis of which a model of the concept system is built, the structure and content of teaching al-Farabi trigonometry in the context of education digitalization focused on the development of students' computational thinking are determined.

Keywords: computational thinking, Al-Farabi trigonometry, block-modular structure, model, learning content.

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ЖОҒАРЫ СЫНЫП ОҚУШЫЛАРЫНЫҢ ЕСЕПТІК ОЙЛАУЫН ДАМЫТУҒА БАҒЫТТАЛҒАН ӘЛ-ФАРАБИДІҢ ТРИГОНОМЕТРИЯСЫН ОҚЫТУ МАЗМҰНЫ МЕН ҚҰРЫЛЫМЫ

Аңдатпа

Әлемдік ғылым мен өркениеттің дамуына баға жетпес үлес қосқан ортағасырлық дәуірдің ұлы ойшылы әл-Фарабидің тригонометриялық мұрасы орасан зор теориялық және практикалық құндылық болып табылады. Онда бір градустағы синусты табудың және практикадағы әртүрлі мәселелерді шешуге қажетті тригонометриялық кестелерді құрудың бірегей алгоритмдері ұсынылған. Оларды заманауи информатика-математикалық білімге қосу ұлы ғалымның мұрасын насихаттап қана қоймай, тригонометрияны оқытудың мазмұнын байытады, оның қолданбалы бағытын күшейтеді, оқушылардың пәндік білім жүйесін кеңейтеді, қазіргі білім беру жүйесінің маңызды мақсаттарының бірі болып табылатын есептік ойлаудың мәнін анықтайтын іскерліктер мен дағдыларды дамытуға ықпал етеді. Әл-Фарабидің тригонометриясын оқыту көрсетілген нәтижелерге қол жеткізуге бағытталуы тиіс. Оқушыларды әл-Фарабидің тригонометриясына оқытудың мақсаттары мен міндеттеріне сәйкес оның пәндік-тақырыптық мазмұнын анықтаған жөн. Зерттеу мақсаты: мектеп оқушыларының есептік ойлау дағдыларын дамытуға бағытталған әл-Фарабидің тригонометриясын оқыту мазмұны мен құрылым анықтау. Нәтижелері: тұжырымдамалар жүйесінің моделі құрылған мазмұнды таңдаудың негізгі принциптері мен әдістері анықталды және оқушылардың есептік ойлауын дамытуға бағытталған білім беруді цифрландыру жағдайындағы әл-Фарабидің тригонометриясын оқытудың мазмұны мен құрылымы анықталды.

Түйін сөздер: есептік ойлау, әл-Фарабидің тригонометриясы, блоктық-модульдік құрылым, модель, оқыту мазмұны.

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СТРУКТУРА И СОДЕРЖАНИЕ ОБУЧЕНИЯ СТАРШЕКЛАССНИКОВ ТРИГОНОМЕТРИИ АЛЬ-ФАРАБИ, ОРИЕНТИРОВАННЫЕ НА РАЗВИТИЕ ИХ ВЫЧИСЛИТЕЛЬНОГО МЫШЛЕНИЯ

Аннотация

Тригонометрическое наследие аль-Фараби – великого мыслителя эпохи средневековья, внесшего неоценимый вклад в развитие мировой науки и цивилизации, представляет огромную теоретическую и практическую ценность. В нем предлагаются уникальные алгоритмы нахождения синуса одного градуса и построения тригонометрических таблиц, необходимых для решения различных задач практики. Включение их в современное информатико-математическое образование позволит не только популяризировать наследие великого ученого, но и обогатит содержание обучения тригонометрии, усиливая его прикладную направленность, расширит систему предметных знаний обучающихся, будет способствовать развитию умений и навыков, определяющих сущность вычислительного мышления, что является одной из важных целей современного образования. Обучение тригонометрии аль-Фараби должно быть ориентировано на достижение указанных результатов. Адекватно целям и задачам обучения школьников тригонометрии аль-Фараби целесообразно определить его предметно-тематическое содержание. Цель исследования: определить структуру и содержание обучения тригонометрии аль-Фараби, ориентированных на развитие навыков вычислительного мышления учащихся. Результаты: определены основные принципы и методы отбора содержания, на основе которых построена модель системы понятий, определены структура и содержания обучения тригонометрии аль-Фараби в условиях цифровизации образования, ориентированные на развитие вычислительного мышления учащихся.

Ключевые слова: вычислительное мышление, тригонометрия Аль-Фараби, блочно-модульная структура, модель, содержание обучения.

Introduction

Digital technologies are rapidly entering the life of modern society and have a great impact on the daily lives of people and the development of the national economy of any country. The expansion of the sphere of digitalization and the use of advanced technologies not only leaves its mark on the organization of knowledge in the modern picture of the world, but also determines the thinking style of modern man. Computer science does indeed have great potential for developing the computational thinking of school children. Its specificity plays a crucial role in honing their computational thinking skills by fostering logical problem-solving, algorithmic thinking, and the ability to understand and devise computational solutions to various real-world problems. Today, the development of students' computational thinking is one of the important tasks of general education in the field of computer science [1-6]. Special attention is paid to teaching schoolchildren trigonometry, developed by the great scientist of the early Middle Ages Al-Farabi in connection with the use of mathematical methods to solve various problems of mathematical astronomy and geography. Interest in the trigonometric heritage of Al-Farabi today causes not only respect for the great scientist and the desire to promote his works, but also has great didactic possibilities and worthy research in the training of mathematics and computer science teachers for both modern school and pedagogical universities. At the same time, its educational aspects and problems of implementation in the educational process have not been considered and reviewed as the separate subject of the study by any reseachers. Its relevance, pedagogical significance and insufficient scientific development were the reasons for choosing the research topic. The purpose of the study is to determine the content and structure of al-Farabi's trigonometry training aimed at developing students' computational thinking.

Research methodology

The following set of methods was used during the research: theoretical analysis of scientific and methodological literature to determine the degree of research on the issue under consideration, taking into account criteria and methods, a model of the conceptual system of the course “al-Farabi trigonometry in the context of digitalization of education” and determining the structure of the content of education.

Results of the study

We consider the methodical system of teaching al-Farabi trigonometry as a pedagogical structure according to A.M. Pyshkalo, the main components of which are the goals, content, methods, forms and means of teaching. The result of training will depend on all these elements, which some leading methodologists call a methodical system of training.

The following principles are based on the construction of goals system for teaching al-Farabi trigonometry to high school students:

1. Correspondence of the goals and objectives of teaching trigonometry to al-Farabi with the current state of science in the field of trigonometry, computer science and informatization of education.

2. Correspondence of the goals and objectives of teaching al-Farabi trigonometry with the state educational standard.

3. Correspondence of the goals for teaching al-Farabi trigonometry with modern processes of modernization and unification of education.

In accordance with these principles, the following goals are set:

1. Enrichment and deepening of the basic knowledge system of students in trigonometry, algorithmization and programming using the algorithmic approach typical for a scientist to solving problems considered by al-Farabi in their learning system;

2. To develop high school students' computational thinking skills necessary for life and self-development in the modern digital world by solving problems from the trigonometric heritage of al-Farabi. This is an important goal of the course and depends on the development strategy of modern society based on knowledge and high-performance technologies.

To achieve the set goals in determining the content of teaching trigonometry al-Farabi, it is necessary to establish a balance between fundamental knowledge of trigonometry and knowledge of algorithmization and programming in a computer science course, structure the teaching material in such a way as to facilitate its understanding by students taking into account its intra-subject and interdisciplinary connections, determine the practice-oriented nature of al-Farabi's legacy and solve all in it, the vision tasks are to implement them on a computer using modern software.

One of the options for presenting educational material may be a block-modular structure that meets modern requirements for the presentation of educational material and the organization of the educational process due to the limited number of hours allocated for classroom training. This approach ensures the transparency of the course allows you to change its content and, with appropriate adjustments, can be used not only in teaching students, but also in the system of training future teachers of computer science and mathematics [7-8].

The block-modular approach to teaching aims to enhance independent activity and provides the following opportunities:

Enhance the effectiveness of learning;

Form creative abilities of students;

Improve the quality of the acquired knowledge;

Form the ability to self-assessment, self-management and self-education.

Moreover, the application of the block-modular approach in teaching will allow:

- to implement differentiation and individualization in teaching depending on the level of students’ knowledge and skills and ensure the progress growth through the program;

-provides flexibility in the content of training through the organization of educational and cognitive activities according to an individual curriculum, adaptation to the individual needs of the individual and the level of its basic training, allows you to study more educational material, despite the reduction in the time allotted for classroom classes.

The theory of modular learning, like any didactic theory, is based on didactic principles that determine its general orientation, purpose, content, ways of organizing and managing the cognitive activity of students. According to the definition of the modern didactician V. I. Zagvyazinsky, "The principle of learning is knowledge of the essence, content and structure of learning in the form of norms of activity, instructions, rules, its laws and patterns." Analyzing the work in the field of modular training, we can highlight the following principles of its organization: modularity, structuring, dynamism, activity, problematic, variability, adaptability, flexibility, continuity, implementation of feedback, conscious perspective and parity [9].

1. The principle of modularity. This determines the modular approach to training, which is reflected in the content, organizational forms and teaching methods. According to this principle, training is built on individual “functional units” - modules designed to achieve specific didactic goals. The module is the main tool for modular learning, it is a complete block of information, and includes a teaching aid that ensures the achievement of didactic tasks set by the target program of activities. In this regard, the content of the module must meet the requirements of consistency, integrity, compactness and independence.

2. The principle of structuring the content of education into separate elements ensures the hierarchy of didactic goals, the consistency and integrity of the report, the logical completeness and independence of the modules, the problematic nature of the content, and the clarity of the appearance of the module. This principle means that the educational material within the module can be considered not only as a single whole, aimed at solving a complex didactic goal, but also as a specific structure consisting of individual elements.

3. The principle of dynamism ensures free change in the content of modules, taking into account the dynamics of the social order. In this form, the module should present its elements in such a way that they can be easily replaced.

4. The principle of flexibility requires the creation of such modules so that the content of learning and the way it is taught can be easily adapted to the individual needs of students. At the same time, it is necessary to ensure control and self-control after achieving a specific training goal.

5. The principle of conscious perspective. This principle requires students to understand future learning prospects. This principle has a broad content. Strict management of students' activities deprives them of initiative and independence, and reduces the role of an independent educational process.

6. The principle of comprehensive methodological consultation. This principle presupposes sufficient provision of professionalism in the cognitive activity of the student and the pedagogical activity of the teacher.

The principles of modular learning are closely related to each other, they all reflect the features of creating educational content.

Traditional teaching emphasizes general didactic principles for the formation of learning content. These include:

- the principle of conformity of the content of education with the needs of social development, based on this, there is a need to add to the content of education not only knowledge, but also fragments that provide the experience of human creative activity and the experience of personal interaction with the value system created by humanity. Today, in the conditions of universal digitalization of society, specialists with computational thinking skills are needed;
- the principle of unity of content and procedural side of education, namely the integrity of subject content, as well as methods of mastering this content;
- the principle of structural unity of the content of education at its different levels.

The focus of the developed teaching methodology on the development of students' computational thinking skills allows us to highlight didactic principles, and based on this, the selection of training content is carried out:

- *the scientific principle* of content includes the correspondence of the teaching content to the modern level of science, the creation in students of correct ideas about the general methods of scientific knowledge, the description of important patterns of the process of scientific knowledge. It is necessary to rely on basic concepts, theorems, algorithms, methods and the current level of development of computer science and mathematics (section of trigonometry);

- *the principle of sequence and order* presupposes the display of meaningful and logical connections, taking into account the cognitive capabilities of students, previous training, and the content of other subjects; To implement this principle, it is necessary to highlight the most important concepts, terms and associations that form the basis of the material being studied. In addition, it is necessary to form a strict logical structure for studying each topic from simple to complex, from unknown to known.

- *the principle of principle of consistency* includes showing the structural connections between blocks of the studied material, adequate to the connections within the scientific theory, paying attention to the system-activity approach to teaching, comprehensive achievement of learning outcomes based on the formation of meta-subject learning. activity;

- *the principle of interdisciplinary communication* includes the study of general theory, laws, concepts, general scientific methodological principles and methods of scientific knowledge, the formation of general educational ways of thinking;

- *the principle of connection between the theory and practice* of learning and life is to observe and explain the content of certain activities, as well as phenomena that arise in certain images of the objects and processes being studied, modeling, thought experiments, etc. d. includes the inclusion of material of an applied nature in connection with the inclusion of related activities;

- *the principle of accessibility* assumes that the volume and complexity of educational material correspond to the real capabilities of the student in the field of its development. Y. A. Komensky formulated the well-known rules for the practical implementation of this principle: from simple to complex, from known to unknown, from simple to complex [10]. At the same time, this principle does not mean simplifying the content of training, since in this case students' interest in learning decreases and the necessary skills are not formed. When teaching al-Farabi trigonometry, this principle requires the teacher to present materials based on previously acquired knowledge and skills from the trigonometry section of the algebra course and the algorithms and programming section of the computer science course necessary for students to successfully master this course;

Memorization and updating of educational information depends on the content of the educational material, forms, methods and means of teaching, as well as the personal attitude of students. This attitude is influenced by various objective and subjective factors: the regional social order for studying the course, students' understanding of the importance of obtaining new knowledge, the microclimate in the team, the level of readiness to perceive the material, the physiological state of the student characteristics, etc. *The principle of differentiation and individualization* involves taking into account the abilities, interests and professional intentions of the student in the content of education;

- *the unity of the teaching content or the principle of integrability* [11], which is expressed in the fact that the integration components in the form of knowledge in mathematics and computer science create the subject "Al-Farabi trigonometry in the conditions of digitalization of education". Firstly, the content of the training is based on the previously studied mathematical apparatus and the apparatus of computer science, namely, knowledge of programming and modern software. Secondly, the mentioned apparatus can be included in the training content as part of it, if it has not yet been considered;

- *the principle of forming a positive attitude* to education and motivation includes the content of education materials about new achievements and innovations, examples of the application of scientific knowledge in life, etc;

- *the principle of developing learning* is aimed at increasing the level of intelligence and cognitive structures of the student's personality, the development of mental cognitive processes of students: feelings, perception, imagination, memory, thinking based on the information approach.

These principles are the main directions and elementary components of the selection of the content of educational material, based on the content of educational material designed to ensure not only the formation of students' ideas about the history of trigonometry, its practical significance, but also the development of their computational thinking skills.

The key to the successful mastering of the curriculum by students, improving the quality of training and the development of computational thinking skills is the selection of the content of the educational material in accordance with the set goals, the creation of a system of concepts and thesauri of the training course [12].

The system of concepts of the training course is understood as didactic, linguodidactic and psychological principles, concepts of a certain subject area, the content of which is expressed taking into account formal, substantive requirements and represents a scientifically and methodically sound integrity, the content of which is necessary and sufficient for the development of students over a certain period of time.

You can use several approaches to constructing a system of concepts for a training course:

- the system of concepts is drawn up in the form of an arbitrary list;
- compiling a thesaurus, (a list of concepts compiled taking into account the connections and relationships between them);
- compiling a list of concepts taking into account the sequence of occurrence of the concepts “connection” and “relationships” (historical approach);
- building a system around one or more concepts with an emphasis on basic concepts in learning;
- orientation of the system of concepts towards teaching students the individual aspect of the subject.

The listed methods and approaches to systematizing the concepts of the subject area are considered in the works of T. A. Kuvaldina, N. I. Pak and others [12-14]. The thesaurus method was used in combination with a logical-semantic approach and analysis of network models to systematize the concepts of the course "The trigonometric Heritage of al-Farabi".

A thesaurus is an interconnected description of the relationships between concepts, as well as a way of describing a system of concepts. According to T. A. Kuvaldina, “an educational thesaurus is a formal model of the system of basic concepts of a training course in the form of an interconnected characteristic of the relationships between concepts in combination with a list of definitions of terms and a set of formal logical schemes” [12].

The thesaurus method allows you to identify the main concepts of the course “The trigonometric heritage of al-Farabi”, establish hierarchical connections between them, establish a logical basis for constructing a model of student’s knowledge at the end of the course, structure the course program at the initial stage of development on a scientific basis, and also determine methods for processing concepts and ways to include them in the student’s individual thesaurus.

The thesaurus can be presented in four parts.

- lexical-semantic (set of terms);
- system index of term descriptors;
- indicator of hierarchical interrelation of term descriptors;
- term permutation index (according to the natural science dictionary, the thesaurus permutation index is a pointer that lists all individual words included in the phrases that form descriptors in alphabetical order, and also indicates all descriptors containing these words for each word).

A descriptor (*describere* in Latin means “*to describe*”) is an unambiguous keyword or code with a fixed meaning that serves to express the main semantic content of the presented text in a more concise form.

The terms that make up a thesaurus can be in one of three different relationships:

- equivalence relations (synonyms);

- intersection relationship (when the semantic meaning of a concept partially intersects with another concept);
- relations of subordination (a situation where one concept is a semantic part of another).

A subject thesaurus can be created top-down, breaking large concepts into components, or bottom-up, starting with small details at low levels of abstraction and integrating them into an overall structure. It is advisable to build the system of concepts related to the course “Trigonometric Heritage of Al-Farabi” from top to bottom. T. A. Kuvaldina identified and showed several stages of creating a model of concepts’ system (Fig. 1).

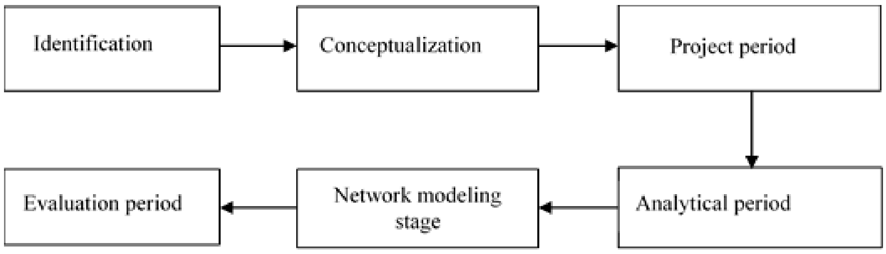

Figure 1. Stages of building a model of a system of concepts

1. At the identification stage, the objectives of the training course are determined.
2. At the stage of conceptualization, the content of the training course is determined, that is, the composition and nomenclature of concepts, the selection of keywords and descriptors, the compilation of a glossary.
3. The design stage involves developing the course content in the form of concepts’ system, creating a model reflecting the natural-logical structure of the system of concepts.
4. At the analytical stage, the model is divided into parts according to individual complex descriptor concepts, as well as topics and sections of the training course.
5. The stage of network modeling includes the creation of formal logical schemes (semantic graphs of concepts) that determine the choice of the network model and the sequence of representation. Petri nets are used to build a network model in the form of positions, transitions and arcs.
6. At the evaluation stage, the analysis of the consistency and accessibility of the model is carried out (i.e., the absence of a “vicious circle” in the relations of terms and relations) [12].

For the course “Al-Farabi trigonometry in the context of digitalization of education”, a model of the system of concepts of this course can be obtained by consistently applying the above stages of constructing a model of the system of concepts (Fig.2). The model is a cylinder divided into layers, each of which has its own semantic load [15-16]. The lowest layer is the areas of reference knowledge that contain the concepts and connections between them necessary for a complete understanding of the material of the proposed course. This layer refers to other subjects that provide interdisciplinary communication: sections “Trigonometry” and “relations between the sides and angles of a right triangle” in algebra and geometry courses, sections “representation and measurement of information”, sections “computational thinking” and subsections “algorithmization” and “programming” in computer science courses.

The following layers of the “cylinder of concepts” are defined hierarchically. Above the base layer there are concepts of the first level, the formation of which is based on basic (reference) knowledge. Connections in the model occur not only between neighboring levels. So, it can be seen that the algorithmic part is included in the entire model through direct communication.

The next section (blocks of second-level concepts) is devoted to the formation of concepts directly related to al-Farabi plane trigonometry. This layer is responsible for the formation of basic ideas about trigonometric straight lines, trigonometric functions through the chord of an arc, methods for finding sine values for some angles, including sin 1 degree, algorithms for tabulating trigonometric functions with the previous level. support.

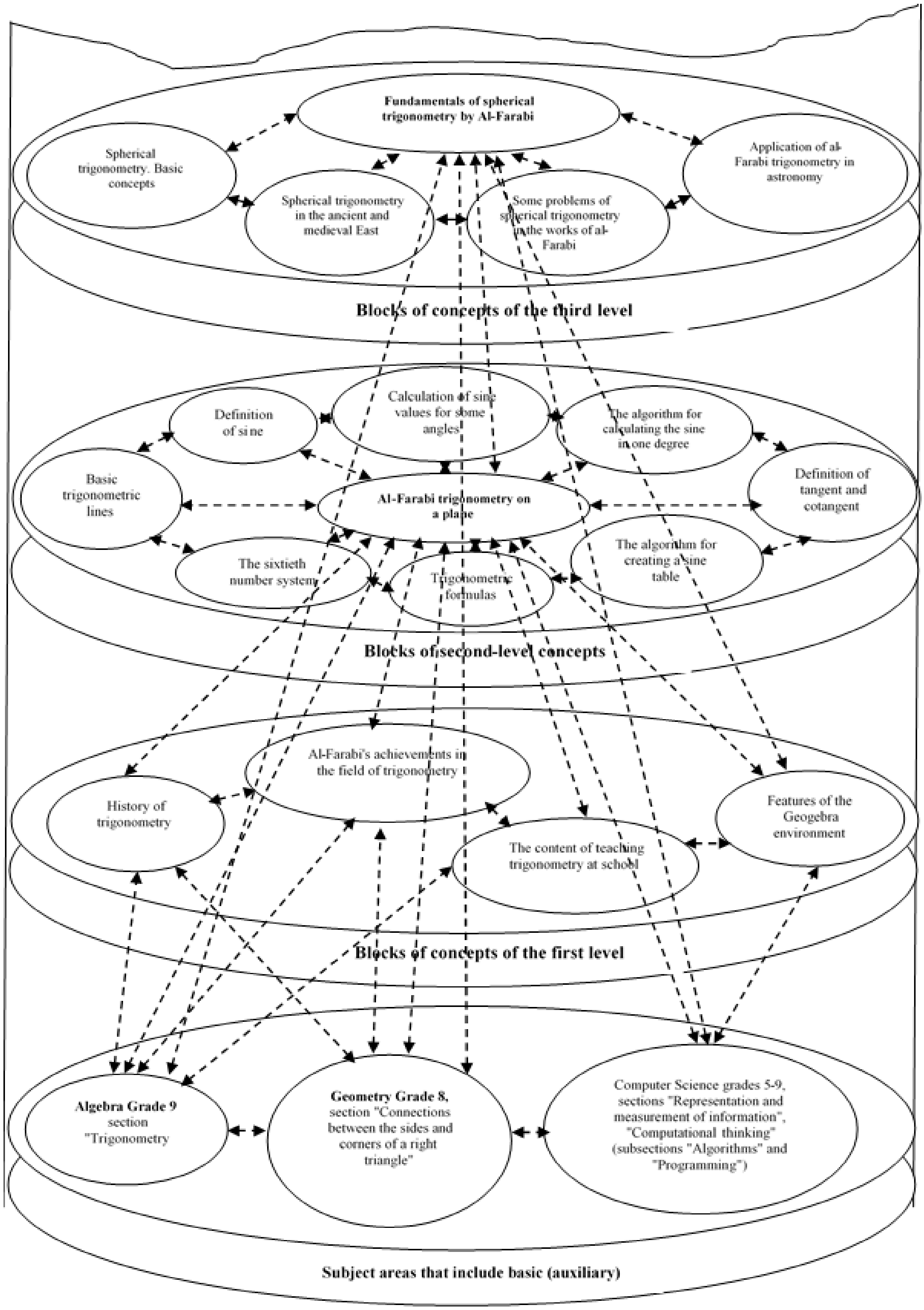

Figure 2. Model of the conceptual system of the course "al-Farabi Trigonometry in the context of education digitalization "

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The third layer of concepts and relationships will be associated with the problems of al-Farabi's spherical trigonometry and its application in astronomy, such as large and small circles on a sphere, the shortest distance between points on a sphere, the concept of spherical trigonometry. triangle, basic formulas of spherical trigonometry. They deepen further understanding of previously acquired knowledge. Knowledge at this level is used to solve complex astronomy problems.

The proposed model can develop on a plane, increase the number of blocks of concepts and connections between them, and also form new, complex levels in height. Based on the proposed knowledge model, in the logic of creating the content of al-Farabi trigonometry in the form of a block-modular structure, it is advisable to implement the following blocks:

- a block containing theoretical data from the history of the development of trigonometry and the definition of the problems it solves, as well as its place in mathematics, its objects and research methods, the role of al-Farabi in the history of the development of trigonometry, trigonometry and its achievements;
- a block containing theoretical information about al-Farabi trigonometry on a plane in the context of digitalization of education. All modules included in this block are mandatory because they cover the basic concepts of al-Farabi, formulas, algorithms and their proofs. Each module of this block, like all other blocks, contains theoretical material, questions and tasks for self-control.
- a block containing theoretical information about al-Farabi spherical trigonometry and its application in astronomy in the context of digitalization of education. Modules 1 and 2 of this module are mandatory for study, since they cover the basic concepts of spherical trigonometry, the history of its development and the role of al-Farabi in it. Modules 3 and 4 are optional, one of them is compulsory for students to choose from.

Figure 3 below shows the structure of the training content in al-Farabi trigonometry, which is integrated into thematic blocks formed on the basis of the proposed knowledge model, taking into account the above principles of content selection.

The first module includes information about the history of the development of trigonometry and the problems it solves, its place in mathematics, as well as the achievements of al-Farabi in trigonometry, their role in the history of the development of trigonometry. One of its main goals is the formation and development of students' constant interest, increasing their motivation to study al-Farabi trigonometry.

The second module of the course presents all the information about trigonometry in the scientist's plane. This material is directly related to the trigonometry section of the school algebra course. The definition of sine here is slightly different, but it is related to the chord widely used by the Greeks at the time. Without limiting this, one can also show its connection with the currently used interpretation of this concept. The need to introduce the sine and the history of the development of this concept can be seen in the "Chronology", info graphics, etc. can be displayed using modern digital tools. This certainly enriches the content of teaching algebra and computer science and strengthens students' knowledge. In addition, other trigonometric functions are introduced. Students are given the task of creating a table of sine values. To do this, first you need to find the value of sin 1 degree. However, you should find it without using calculator and an accessible table.

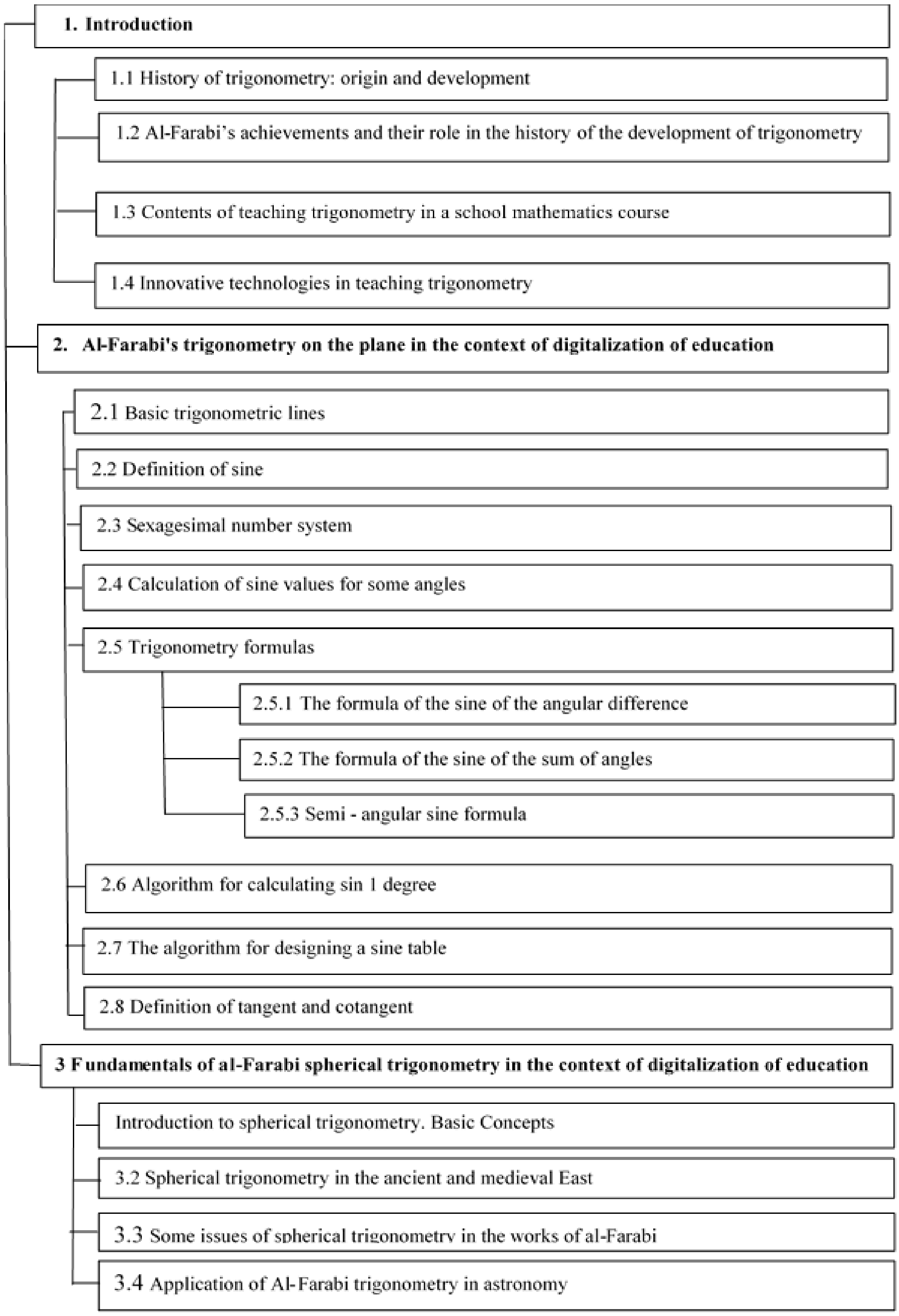

Figure 3. Structure of the educational content of the course "al-Farabi Trigonometry in the context of digitalization of education"

What is al-Farabi suggesting here? Break the problem into small, easily solvable parts, i.e. decompose it (decomposition). The proof of trigonometric formulas, finding the values of the sine for some grades: the difference sine and the sum of two grades, the semi-argumentative sine is considered in the scientist's legacy as part of the solution to the problem of finding a sin 1 degree and designing a table. Values within a certain range based on it. Each of them represents a separate task; once the student starts solving it, he can concentrate on solving the remaining problems. Nevertheless, he understands what it takes to solve this problem. He becomes more interested in it and learns to make more decisions that are meaningful.

The algorithmic approach used by al-Farabi in solving mathematical problems makes it possible to simplify the presentation of the solution to each of the problems under consideration in the form of a sequence of steps and implement it on a computer. A student can write algorithms for solving both problems and general problems of the sine table in different ways. This will not only enhance students' knowledge of trigonometry but will also develop their algorithmic skills. Students can generalize the algorithm for solving the problem of constructing a table of sines to other trigonometric functions. Analyzing the algorithm and how the program works helps them develop their evaluation skills.

In the modern digital environment, their solution is impossible to imagine without using the capabilities of a computer, and students should know this. Of course, the task of creating a table of trigonometric functions requires automation, development and implementation of a program based on algorithms created by al-Farabi. This helps students develop the ability to recognize real problems and use computers to solve them. At the same time, it contributes to the development of their programming skills.

Discussion

The course content includes the study of the sexagesimal number system, which was common among the ancient Greeks and was used in calculations in the Middle East in ancient times. Moreover, in al-Farabi trigonometry, calculations are given in the sexagesimal number system. Unlike many other number systems, the sexagesimal system is practically not used in computer science, but is becoming increasingly convenient for measuring angles and geographic coordinates. The standard unit of sexagesimal is Degrees (360 degrees), followed by minutes (60 minutes = 1 degree) and then seconds (60 seconds = 1 minute). Currently, the sexagesimal system is mainly used to measure angles and time. Additionally, the sixty-year system in the People's Republic of China outside Europe is sometimes applied not only to seconds and minutes, but also to years. The third module examines spherical trigonometry, the history of its development and some problems of application in astronomy in the works of al-Farabi. Its main purpose is to enhance students' knowledge of trigonometry and develop computational thinking skills. Structurally, all modules include:

- sections with specific goals containing theoretical information; a deductive method is used to present it (up to examples and practical actions on concepts);
- exercise tasks that require the use of module information to analyze the student’s real practical activities;
- brief conclusions on the content of each section;
- methods for assessing the quality of work performed;
- bibliography by sections.

The above course content is mainly aimed at developing students' computational thinking skills (Table 1).

Table 1. Matrix of distribution of computational thinking skills by module topics

№	*Computational thinking skills*	*Subject module that promotes skill development №*									
		2.1	*2.2*	*2.3*	*2.4*	*2.5*	*2.6*	*2.7*	*2.8*	*3.1*	*3.2*
1.	*Decompose (decomposition)*				+	+	+	+		+	+
2.	*Abstraction*	+	+		+	+	+	+	+		+
3.	*Algorithmization*			+	+	+	+	+		+	+
4.	*Generalization*		+			+		+			+
5.	*Assessment*		+			+	+	+	+		+

Conclusion

In conclusion, we can say that when choosing content for introducing a new discipline (or supplementing an existing program), work is often required to determine methods, techniques, teaching aids, a range of tasks for practical activities, the topic of projects, the content of independent work and other aspects of the educational process.

In this regard, the content of the course "al-Farabi trigonometry in the context of digitalization of education" was compiled, dedicated to the development of students' computational thinking skills.

References

[1] Wing J. Research Notebook: Computational Thinking – What and Why? –2010. – URL: http://www.cs.cmu.edu/link/research-notebook-computational-thinking-what-and-why

[2] Operational Definition of Computational Thinking for K-12 Education. Computer Science Teachers Association [Электрон. ресурс]. – 2011. – URL: http://csta.acm.org/Curriculum/sub/CompThinking.html

[3] Хеннер Е.К. Вычислительное мышление /Образование и наука. – 2016. – № 2(131). – С.18-33. – URL: https://doi.org/10.17853/1994-5639-2016-2-18-33

[4] Мукашева М.У. Программирование в школе и вычислительное мышление. /Вестник ЗКУ, 2018. – №4(72). – С.48-59

[5] Берман Н.Д. Роль информационных технологий в развитии навыков вычислительного мышления / Мир науки. Педагогика и психология. 2019. – №2, том 7. – С.1-8

[6] Баранов А.В Дидактический потенциал учебных физических задач в формировании вычислительного мышления студентов IT-направлений//Научно-педагогическое обозрение. Pedagogical Review. 2019. – №1(23). – С.144-150. –DOI 10.23951/2307-6127-2019-1-144-150

[7] Wing J. Computational Thinking // Communications of the ACM. – 2006. – Vol. 49 (3), p.33-35. https://doi.org/10.1145/1118178.1118215.

[8] Aho A.V. Computation and Computational thinking //The Computer Journal. – 2012. – V.55, No.7, p.832-835. https://doi.org/10.1093/comjnl/bxs074

[9] Шамова Т.И., Давыденко Т.М, Шидамова Г.Н. Управление образовательными системами: Учеб.пособие для студентов высш.пед.учеб.заведений.- М.:Издательский центр «Академия». 2002.- 384 с.

[10] Селевко Г.К. Энциклопедия образовательных технологий: В 2 т. Т. 1. М.: НИИ школьных технологий, 2006. – 816 с.

[11] Макарова Н.В. Научные основы методической системы обучения студентов вузов экономического профиля новой информационной технологии. Диссертация на соискание научной степени д.пед.н. в форме научного доклада. – СПб, 1992. –53с.

[12] Кувалдина Т.А. Систематизация понятий курса информатики на основе методов искусственного интеллекта. Дисс. на соиск. степени д. пед. наук: Москва. – 2003.-280 с. *13.00.02,*

[13] Григорьев С.Г., Гриншкун В.В., Кувалдина Т.А. Иерархии в моделировании логической структуры предметных областей // Материалы VI Общероссийской научной конференции «Современная логика: проблемы теории, истории и применения в науке». СПб.: Санкт-Петербургский университет, 2000.

[14] Пак Н.И. Информационное моделирование: учебное пособие. Красноярск: РИО КГПУ, 2010. – 152 с.

[15] Сокольская М.А. Отбор содержания курса «Основы параллельного программирования» на основе информационного подхода. // Вестник Красноярского государственного педагогического университета им. В.П. Астафьева. Красноярск: КГПУ, 2011. №3 (17). С. 180 – 185

[16] Сокольская М.А. К вопросу отбора содержания курса «Основы параллельного программирования» на основе логико-семантического подхода и тезаурусного метода // Всероссийская научно-методическая конференция «Инновационная интегрированная система профессионального образования: методы и пути решения»: материалы конференции. Красноярск: Сибирский государственный аэрокосмический университет, 2011. С. 360 – 362.

References

[1] Wing, J. (2010). Research Notebook: Computational Thinking – What and Why? URL: http://www.cs.cmu.edu/link/research-notebook-computational-thinking-what-and-why (In English)

[2] Operational Definition of Computational Thinking for K-12 Education. (2011). Computer Science Teachers Association. [Jelektron. Resurs], URL: http://csta.acm.org/Curriculum/sub/CompThinking.html (In English)

[3] Henner, E.K. (2016). Vychislitel'noe myshlenie [Computational Thinking]. Obrazovanie i nauka, 2(131), 18-33. URL: https://doi.org/10.17853/1994-5639-2016-2-18-33 (In Russian)

[4] Mukasheva, M.U. (2018). Programmirovanie v shkole i vychislitel'noe myshlenie [School programming and computational thinking]. Vestnik ZKU, 4(72), 48-59 (In Russian)

[5] Berman, N.D. (2019). Rol' informacionnyh tehnologij v razvitii navykov vychislitel'nogo myshlenija [The role of information technology in the development of computational thinking skills]. Mir nauki: Pedagogika i psihologija, 2 tom 7, 1-8 (In Russian)

[6] Baranov, A.V. (2019). Didakticheskij potencial uchebnyh fizicheskih zadach v formirovanii vychislitel'nogo myshlenija studentov IT-napravlenij [Didactic potential of educational physical tasks in the formation of computational thinking of IT students]. Nauchno-pedagogicheskoe obozrenie, Pedagogical Review, 1(23), 144-150. DOI 10.23951/2307-6127-2019-1-144-150 (In Russian)

[7] Wing, J. (2006). Computational Thinking. Communications of the ACM, 49 (3), 33-35. https://doi.org/10.1145/1118178.1118215 (In English)

[8] Aho, A.V. (2012). Computation and Computational thinking. The Computer Journal, 7, 832-835. https://doi.org/10.1093/comjnl/bxs074 (In English)

[9] Shamova, T.I., Davydenko, T.M., Shidamova, G.N. (2002). Upravlenie obrazovatel'nymi sistemami [Management of educational systems]. Uchebnoe posobie dlja studentov vyssh.ped.ucheb.zavedenij. M.:Izdatel'skij centr «Akademija». 384p. (In Russian)

[10] Selevko, G.K. (2006). Jenciklopedija obrazovatel'nyh tehnologij [Encyclopedia of Educational Technologies] V 2 t. T. 1. M.: NII shkol'nyh tehnologij. 816 p. (In Russian)

[11] Makarova, N.V. (1992). Nauchnye osnovy metodicheskoj sistemy obuchenija studentov vuzov jekonomicheskogo profilja novoj informacionnoj tehnologii [Scientific foundations of the methodological system of teaching students of universities of the economic profile of the new information technology]. Dissertacija na soiskanie nauchnoj stepeni d.ped.n. v forme nauchnogo doklada. SPb, 53p. (In Russian)

[12] Kuvaldina, T.A. (2003). Sistematizacija ponjatij kursa informatiki na osnove metodov iskusstvennogo intellekta [Systematization of computer science course concepts based on artificial intelligence methods]. Diss. na soisk. stepeni d. ped. nauk: 13.00.02, (In Russian)

[13] Grigor'ev, S.G., Grinshkun, V.V., Kuvaldina, T.A. (2000). Ierarhii v modelirovanii logicheskoj struktury predmetnyh oblastej [Hierarchies in modeling the logical structure of subject areas]. Materialy VI Obshherossijskoj nauchnoj konferencii «Sovremennaja logika: problemy teorii, istorii i primenenija v nauke». SPb.: Sankt-Peterburgskij universitet, (In Russian)

[14] Pak, N.I. (2010). Informacionnoe modelirovanie [Information modeling]. uchebnoe posobie. Krasnojarsk: RIO KGPU, 152 p. (In Russian)

[15] Sokol'skaja, M.A. (2011). Otbor soderzhanija kursa «Osnovy parallel'nogo programmirovanija» na osnove informacionnogo podhoda [Selection of the content of the course "Fundamentals of parallel programming" based on an information approach]. Vestnik Krasnojarskogo gosudarstvennogo pedagogicheskogo universiteta im. V.P. Astaf'eva. Krasnojarsk: KGPU, 3(17), 180-185 (In Russian)

[16] Sokol'skaja, M.A. (2011). K voprosu otbora soderzhanija kursa «Osnovy parallel'nogo programmirovanija» na osnove logiko-semanticheskogo podhoda i tezaurusnogo metoda [On the issue of selecting the content of the course "Fundamentals of parallel programming" based on the logical-semantic approach and the thesaurus method]. Vserossijskaja nauchno-metodicheskaja konferencija «Innovacionnaja integrirovannaja sistema professional'nogo obrazovanija: metody i puti reshenija»: materialy konferencii. Krasnojarsk: Sibirskij gosudarstvennyj ajerokosmicheskij universitet, 360-362.