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MATHEMATICAL TRAINING OF ECONOMIC SPECIALISTS IN AGRICULTURAL INSTITUTIONS OF HIGHER EDUCATION

Аннотация.

В статье доказывается, что на первый план в подготовке будущих аграриев выходит формирование математической компетентности. Она является составной профессионально-инновационной компетентности и позволит будущему специалисту качественно выполнять поставленные задачи в современной высокотехнологичной и интелектуальноемкой профессиональной среде.

Теоретически обосновываются принципы внедрения интегративного математического содержания образования в систему целостной профессиональной подготовки экономистов-аграриев. Рассматриваются принципы, объединенные в комплекс, фундаментализации и профессионализации, целостности и предметной дифференциации, последовательности, научности и доступности.

Раскрывается сущность и содержание дидактического комплекса учебно-методического обеспечения интегрированной математической подготовки специалистов, его особенности и характеристики, как средства оптимизации профессиональной подготовки.

Предложенный подход существенно оптимизирует процесс профессиональной подготовки, поскольку, происходит уплотнение ее содержания, увеличение информационной емкости, появляются широкие возможности для гибкости и вариативности обучения.

Дидактический комплекс учебно-методического обеспечения интегрированной математической подготовки специалистов позволит будущим специалистам сформировать необходимые компоненты математического мышления: уровень, кругозор, культуру и методы, что является необходимым условием для формирования их профессиональной компетентности.

Abstract.

The article proves that the formation of mathematical competence comes to the fore in the training of future farmers. It is a component of professional-innovative competence and will allow the future specialist to qualitatively perform the set tasks in the modern high-tech and intellectually intensive professional environment.

The principles of introducing the integrative mathematical content of education into the system of integral professional training of agrarian economists are theoretically substantiated. The principles, combined in a complex, fundamentalization and professionalization, integrity and subject differentiation, consistency, scientific character and accessibility are considered.

The essence and content of the didactic complex of educational and methodological support of integrated mathematical training of specialists, its features and characteristics, as a means of optimizing professional training are revealed.

The proposed approach significantly optimizes the training process, because, there is a consolidation of its content, increasing the information capacity, there are ample opportunities for flexibility and variability of learning.

The didactic complex of educational and methodical support of integrated mathematical training of specialists will allow future specialists to form the necessary components of mathematical thinking: level, outlook, culture and methods, which is a necessary condition for the formation of their professional competence.

Ключевые слова: *интеграция, математическая подготовка, специальная подготовка агрария, экономическая подготовка, научно-методический комплекс.*

Keywords: *integration, mathematical training, special training of a farmer, economic training, educational and methodological complex, principles of teaching, innovative training.*

Formulation of the problem. The market economy significantly increases the requirements for the quality of training of graduates of agricultural universities. A modern highly qualified agrarian economist must be able to navigate freely in a diverse range of professional issues, competently set tasks, find optimal methods for solving them, be able to choose the right package of computer programs.

In connection with the global challenges facing the agricultural sector of Ukraine's economy, its reorientation to the European economic system, employers are making new demands on future professionals. The introduction and use of the latest intelligent equipment and technologies require fundamental and universal knowledge.

As a science of the objective causes of the functioning and development of society, economics uses a variety of quantitative characteristics and a large number of mathematical methods for studying these characteristics. Now the mathematical model as a tool of research and forecast of economic phenomena comes to the fore. Despite the fact that it is possible to actively use the mathematical apparatus only after mastering the necessary knowledge in the field of axiomatic mathematics, integrating within economic activities in the agricultural sector, knowledge from many fields (mathematics, biology, geography, chemistry, computer science, etc.), Future specialist thus it is possible to comprehensively cover the range of professional problems [1].

In this context, the role of fundamental knowledge, the basis of which is mathematical, is growing. In our opinion, in modern conditions a special place in higher agricultural educational institutions should be occupied by mathematical training, which is in fact invariant in relation to the professional training of specialists different profile. It is its components, being an integral part of agricultural education, deepen students' understanding of the place and importance of their profession in innovation, stimulate awareness of the possibility of using mathematical knowledge as a means of solving professional problems, social prestige of the profession, ie contribute to deepening professional worldview.

Therefore, the formation of mathematical competence as a component of professional and innovative competence comes to the fore in the training of future farmers, which will allow the future specialist to perform the tasks in a modern high-tech and intellectually intensive professional environment.

An essential characteristic of a market economy at the present stage is economic freedom, ie the ability to make independent decisions on the search and choice of form, type and scope of economic activity, methods of its implementation, product use and income. This requires new qualities in specialists: flexibility, mobility, breadth of thinking, reflection [2].

This requires constant updating of the components of vocational education, development and implementation of new pedagogical technologies between them and integration [3].

Implementation of the integration of the content of professional training of students of economic specialties of agricultural higher educational institutions can be carried out within the existing state regulations. It is obvious that mathematical training is the basis for training a specialist in any sector of the agricultural economy. Economic specialization is impossible without sound mathematical training.

In many disciplines of the professionally oriented cycle, mathematical knowledge serves as one of the foundations on which their content is built. Based on the comments, we believe that the integration of the content of mathematical and special training, which consists in changing the components and structure of the content, deepening existing and introducing new integrated knowledge and skills, should be based on the content of mathematics and disciplines. based on it: finance, statistics, econometrics, mathematical modeling of economic processes and the like.

Analysis of recent research and publications. The problem of formation of professional-mathematical competence of specialists of different profile in higher education is considered in researches of O. Averena, R. Blokhina, G. Zhukova, G. Ilarionova.

In developing the theoretical and methodological aspects of the problem, scientific and methodological research on improving the methods of teaching mathematics to environmental students (N. Gavrish, T. Emelyanova, O. Poltavska, T. Yarkho) was important for us.

In our study, we relied on the work of scientists who studied the problem of formation of mathematical knowledge, skills and abilities (M. Burda, M. Zhaldak, P. Erdniev, M. Ignatenko, T. Krylova, M. Metelsky, Z. Slepkan, A. . Carpenter, I. Teslenko, M. Shkil, N. Shunda).

Different levels of integration are considered in the theory of didactic integration. We focused on the analysis of the transformation procedure at the level of a particular discipline. In the process of forming an integrated course, we relied on both empirical and partly theoretical experience, based on the thesaurus approach described by Yu. Semin [4].

According to the model of integrative activity developed by M. Chapaev, the establishment of integrative relations involves the allocation of an integrative basis and analysis of the integrative potential of disciplines that are provided by the curriculum [5]. Accordingly, we analyzed the content of mathematical, natural science and vocational education, which showed that the content of the thesaurus is almost the entire content of mathematical training and related system of principles of invariance of natural sciences. Analysis of the nature of integration relations between disciplines allowed us to conclude that in the first year as a fundamental basis can be mathematical disciplines, which in the process of integration play a systemic role. The introduction of logical-procedural operations into the content of mathematical training - unification of concepts, universalization and extrapolation of mathematical methods, as well as components of knowledge: concepts, laws, theories that have integrative potential contributed to the strengthening of integration ties. In the process of creating the integrated content of the course, we used the main mechanisms of integrative activity, described by J. Piaget: assimilation, accommodation, balance [6].

It was also established that due to the possibility of computer modeling of natural processes, the circumstances that previously hindered the convergence of mathematics and natural sciences were eliminated, which contributed to the emergence of a new quality of mathematics education - vocational guidance. It is the achievement of this quality that allows vocational education to combine training and production components.In the process of the described methodical complex the system-forming factor became productive activity, as approach to professional.

The selection of the integrated content of mathematical training is not yet a guarantee of solving the problem of integration of professional training. It is important to determine ¬ how, to what extent and in what sequence to introduce this content into the holistic process of vocational education and achieve the goals. To do this, it is necessary to define a system of norms that regulate the formation of the content of education, taking into account its integration. Principles can act as such norms. I. Kozlovska notes: "A necessary condition for the effectiveness of an integrative approach to learning is the analysis of the interaction of integrative ideas with the basic principles of didactics" [7, p.75]. The question of the principles of development of integrative courses in vocational education is raised by J. Sobko. He notes: "compliance with the requirements of the principles of development of integrative courses in vocational education, strengthens the relationship of general education, general technical and vocational training of students" [8, p.122].

Formulation of the goals of the article. To substantiate the system of principles that regulate the formation of integrated content of mathematical training in the system of professional training of future economists-farmers.

To reveal the essence and content of the didactic complex of educational and methodical support of integrated mathematical training of specialists, built in compliance with these principles. Justify its features and characteristics as a means of optimizing the training of specialists.

Main material presentation. In this article we will demonstrate the ways of formation of innovative competence of future farmers during the study of mathematical disciplines in the conditions of deepening integration relations in the system "science-education-production".

The process of formation of a new educational formation in terms of intellectual saturation of professional activity is accompanied by transformations of specialized training in the direction of problem-oriented with universal fundamental training, which provides opportunities for self-education, retraining, change of professions.

Given the above, an important principle of building a model of the future economist-agrarian is the principle of advance training in comparison with the pace of change in professional activity.

We believe that the ideas of professional-competence model of teaching mathematical disciplines to specialists of economic profile, which is based on deep integration with the disciplines of the economic cycle and implemented through the introduction of modern information technology in the educational process based on its information and computer support interpret and apply in the training of farmers [9, p.14].

When studying mathematics, various components of students' readiness for future professional activity are manifested. Solving mathematical problems requires the use of many mental skills: to analyze a given situation, compare data and what is sought, to construct the simplest mathematical models, carrying out a thought experiment; synthesize, selecting useful information, systematizing it; briefly and clearly, in the form of text, symbolically, graphically express their thoughts; objectively evaluate the results when solving the problem, summarize the results of the problem, investigate the special manifestations of a given situation. All this requires a deepening of ideas about the basics of the organization of mathematical education in agricultural universities, which provides the acquisition of knowledge and skills in unity with the development of "core" personality traits. At the same time, it is important to reveal some general provisions of improving the professional training of specialists by means of general scientific disciplines on the material of teaching subjects of the mathematical cycle.

Teaching mathematics stimulates awareness of its role as the foundation of special disciplines; deepens the understanding of the need to master the skills of synthesis of general and special knowledge for their application in practice; contributes to the understanding of the role of general scientific methods of cognition in solving production problems (analogies, generalizations, abstractions, algorithms, ascents from the abstract to the concrete, etc.); promotes the mastery of operations of heuristic, prognostic thinking, necessary for professional activity; encourages to transform general methods of cognition into professional ones; awakens the desire to use the learned methods of cognition in practice; promotes the development of generalized methods of analysis of specific processes in nature. In this regard, the French mathematician A. Poincaré emphasized another aspect of the formation of a mathematical culture of thinking: "The main purpose of teaching mathematics is to develop certain abilities of the mind, and between these abilities, intuition is not the least valuable. Thanks to her, the world of mathematical images is intertwined with the real world ... " [10, p.346].

"The principles of teaching established in pedagogy… are generalized, and in some cases their use requires more detailed clarification, which is mostly the subject of research" [11, p.108]. Given the problem we have raised, we propose adapted already formed in pedagogical science, the principles combined into a complex.

Such principles include: the principle of fundamentalization and professionalization, integrity and subject differentiation, continuity, scientificity and accessibility. The set of principles in their interaction is designed to regulate the resolution of all major contradictions that arise in the process of introducing new technologies in the training process. In general, it can be argued that the principles govern the resolution of conflicts between training objectives and the conditions in which these objectives are implemented.

Leading among these principles is the principle of fundamentalization and professionalization. However, it can be a means of integrating vocational education only in conjunction with other principles. The principle of fundamentalization and professionalization not only in a new way allows you to organize the content of training, but also gives it new qualities. It is system-forming in a set of principles of formation of the integrated content of education. This principle is also important because it reflects both the ultimate goals of the process of improving the content of mathematical training as a component of holistic training, and a means to achieve them.

Consider each of the principles in more detail. The principle of fundamentalization and professionalization reflects the dialectical unity of two trends in vocational education, which lie on one line. However, they have different directions. On the one hand, strengthening the applied, professional orientation of education qualitatively improves the training of specialists. However, the professional mobility of the future specialist is limited, due to the narrow focus of such training.

On the one hand, the strengthening of fundamental training contributes to the general cultural and intellectual development of the individual, but does not allow to speak about the completion of training, and hence the professional competence of the specialist.

This principle regulates the ratio of fundamental and applied in the content of holistic professional education in the process of studying general education, general professional and special disciplines; indicates the links between fundamental and applied and ways of introducing fundamental content into the educational process; directs to the simultaneous formation of fundamental and professional knowledge, skills and personal qualities of the future specialist.

In terms of training, which combines general and special training into a single whole, the emphasis is on special types of combination until the full integration of fundamental and applied as a holistic system. The fundamental elements of the content of education are highlighted: knowledge, methods of activity, personal qualities organically fit into the disciplines of the respective cycles - general education, general professional, special.

If "the principle is a general guiding norm of action, and the rule is a norm of action that has a specific working value" [12, p.81], then, as a concretization, we also highlight the rules.

In accordance with the principle of fundamentalization and professional orientation, in order to introduce integrated mathematical content into the educational process, the following rules should be followed.

1. Include in the content of vocational education knowledge, skills, abilities, personal qualities that are the basis of professional competence (professional readiness, intellectual and cultural development of the individual, which are necessary for both professional activities and for continuing education).

2. To allocate fundamental knowledge in the mathematical content of training for the purpose of their further in-depth study.

3. Based on integration, include fundamental mathematical knowledge in the disciplines of general and special cycles.

4. The content of the scientific-fundamental component to include mainly in mathematics.

5. The content of the professional-fundamental component should be included in the relevant disciplines of the general professional and special cycles.

The principle of integrity and differentiation regulates the contradiction between the integrity of the result (professional competence of the specialist) and, divided into parts, differentiated by disciplines, professional education. Integrated education, as the basis of the content of vocational education, undoubtedly strengthens its integrity. However, such education, having its own structure and internal relationships, is an independent system, which is also characterized by integrity. Integrated education is not limited to one methodological discipline. It is divided into different disciplines of vocational education, however, without violating the integrity of these disciplines.

In accordance with the principle of integrity and subject differentiation, in the case of the introduction of integrated mathematics education in holistic vocational education should be guided by the following rules.

1. The introduction of integrated mathematics education should not violate the integrity of vocational education and its content.

2. Introduce into the content of education not only integrated knowledge, but also integrated ways of working (skills) and integrated values that are part of holistic education.

3. In academic disciplines it is necessary to introduce the material that strengthens its integrity and at the same time strengthens ties with other disciplines.

4. Integrated content should not be a growth that overloads disciplines.

5. It is possible both the direct implementation of integrated mathematics education and contextual, which is characteristic of the formation of integrated activities and integrated values.

The principle of continuity reflects the relationship of past, present and future. It regulates the gradual transition from one quality to another. The essence of continuity in the content of education is the idea of gradualness and consistency - from small to large, from simple to complex, from elementary to complex, and then to the system. What is clear before helps to understand the following. Continuity helps to ensure the homogeneity of the content, eliminates the appearance of unnecessary in it, removes outdated, contradictory elements for this system of knowledge. In the context of our study, it should be noted that part of the integrated mathematical knowledge was studied in secondary school. However, as practice shows, most school graduates do not have integrated knowledge. This fact has led us to the need to include in the course of mathematics integrated topics, sections, in order to restore and form integrated mathematical knowledge and skills. On the other hand, the content of this course is also subject to the principle of continuity, both in the internal connection of the elements and in the external, ie the use of integrated knowledge in other disciplines. The principle of continuity in order to implement the integrated content of education involves the management of rules.

1. Introduce those knowledge and skills that are consistent with the existing content, as well as previous and next.

2. Use previous knowledge as a support for the formation of new ones.

3. Preservation of old knowledge in the system of new ones. Creation of new as development of old.

4. The integrated content of mathematical training should contain mutually agreed elements of the old and the new.

5. Ensure compatibility, smooth transition between the content of secondary and vocational school education.

6. Professionally integrated content of mathematics education should promote the study of special disciplines.

7. Introduce promising knowledge and skills in order to create an "intellectual stock" and a basis for continuing education throughout life.

8. If necessary, develop content and implement an integrated course that will provide quality system training.

Mathematical knowledge cannot be divided into primary and secondary knowledge. They all contribute to the formation of mathematical competencies. The sequence of topics is traditionally determined by the logic of the discipline.

For example, mastering the theory of differential calculus as abstract mathematical knowledge, students do not understand the described applied function of mathematics, which narrows the possibilities of mastering the ability to describe agronomic processes with mathematical models, the possibility of professional thinking. This, in turn, reduces the value attitude to mathematics as the most important means of professional activity, forms a negative attitude towards it, which impoverishes the entire system of professional orientations.

The study showed that the students who learn each new section of mathematics as new knowledge, without making generalizations with previously studied, do not see analogies in the structures and applications of the studied theories, do not seek to identify basic

knowledge, do not predict its application. They are usually poorly acquainted with the essence of mathematical generalizations, analogies, algorithms, because they do not understand, do not realize the effects that mathematical methods have on the formation and development of professional thinking.

Conversely, understanding the new possibilities of professional activity, based on a broader mathematical basis, students later seek to master the theory of optimization, control, linear and dynamic programming.

The principle of scientificity and accessibility indicates the need to build the content of the discipline in accordance with scientific ideas and achievements in science, taking into account the intellectual, cognitive abilities of students studying this discipline. The content of education should reflect a holistic picture of the world, patterns of development of nature, society, man, methods of scientific knowledge. The content of integrated mathematical training should correspond to the logic of the science of mathematics.

The rules for implementing this principle in the formation of the content of integrated mathematical training in the system of holistic vocational education have the following formulations.

1. Introduce scientific fundamental knowledge and methods into the content of education.

2. Ensure compliance of the content of the discipline with the relevant field of science (subject area).

3. Use scientific methods and strive for unambiguity of scientific terms used in scientific knowledge and teaching.

4. Do not violate the logic of the discipline in the process of introducing the necessary integrated knowledge.

5. Modern scientific achievements that are integrated should be included in the content of education, if it is possible to adapt this knowledge to the existing level of training and the possibility of their assimilation by students.

6. Provide an adequate level of volume and degree of theoretical complexity of the content of integrated mathematical training for students to understand.

7. The content of education should encourage further knowledge.

The principles of forming the content of integrated mathematical training, specified by the relevant rules, are implemented at all stages of formation: assessment of the use of integrative potential of existing disciplines, changing the structure and composition of training content, checking the effectiveness of training integration, correction of integrated mathematical training.

Based on these principles, we have built a scientific and methodological complex of mathematical training of future economists-farmers.

The complex allows to provide training that meets modern requirements for training.

The purpose of the educational complex is:

- implementation of integrated study of higher mathematics and elements of special economic disciplines based on mathematics;

- formation of detailed ideas about economic reality in the branches of agro-industrial complex, its deep fundamental basis;

- construction of a reliable base for future economists-agrarians to gain further professional knowledge;

- development of students' independence and ability to apply theoretical material to the quantitative analysis of practical problems;

- development of system thinking;

- formation of information culture;

- formation of abilities and needs to expand and deepen the system of interconnected knowledge and spread them to connections with other disciplines;

- formation of generalized personal skills and abilities, which have, first of all, a practical orientation.

The course, built on an integrated basis provides the following educational tasks:

- acquaintance with the main sections of higher mathematics, which are necessary for modeling professional tasks;

- Demonstration of the relationship between mathematics and economics;

- development of skills of application of mathematical methods for the analysis of professional problems;

- formation of skills for selection and simplest information processing.

- The developed complex contains didactic materials (curricula of meta-subjects with integrated content "Mathematics for economists-agrarians" and "Mathematical modeling in agrarian economy", graphs of modular control, blocks of tests, test tasks, exam tickets) and didactic set of textbooks and methodical instructions that contain theoretical material, tasks for practical classes and independent work, reference materials.

In the context of the coronavirus pandemic (COVID-19), distance learning courses have become a forced and almost the only emergency alternative to the classical organization of the educational process around the world. During quarantine, when most educational institutions are completely or partially closed, this encouraged educators to creatively study effective distance learning practices and find optimal ways to achieve educational outcomes in a particular educational system. In this regard, we supplemented the methodological complex with a video lessons course created and tested during distance learning and provided students with open access to materials.

Due to which a number of advantages are achieved: the ability to study anytime anywhere, at your own pace, without separation from the main activity, the creation of an individual educational trajectory, the availability of educational materials, cheapness.

The content of the didactic complex is formed on the basis of normative documents, which are now guided in the process of training, studying the main trends of production activities of graduates in accordance with the prospects and priorities of scientific, technical, socio-economic and sociocultural development. combined with the principles of modular learning using new information technologies. The essence of the didactic complex corresponds to the content of a full-fledged manual, defined by V. Bezpalko as a complex information model of the pedagogical system [13]. It describes the functioning of this system, provides the

content of training, taking into account the general didactic requirements, determines the organizational forms of training for which it is intended.

The didactic complex is an open subsystem of the didactic system, ie it remains possible to supplement it with in-depth textbooks, add new textbooks with integrated content from other disciplines, based on them to create optional courses, such as "Introduction to the specialty".

The complex is based on textbooks: "Mathematical analysis for economists-farmers", "Mathematical workshop for economists-farmers. Series", "Probability theory for economists-farmers", "Mathematics for entrants to agricultural universities" [14-17], which contain the information part of the training modules. In the process of their creation, the following requirements were met: the manual should serve as an organizer of systematic cognitive activity of students, a means of management in their independent cognitive activity. These requirements were implemented on the basis of the optimal combination of accessibility and scientificity, breadth and depth of teaching, rigor and clarity.

The manual "Mathematical Analysis for Agricultural Economists" was created to implement a modular organization of education using new information technologies based on the integration of higher mathematics and economics. It compactly presents the mathematical apparatus, contains examples of the application of mathematics in economics, most of which are illustrated by solutions in the Mathcad environment. Wherever appropriate, economic interpretation of mathematical concepts is given, mathematical formulations of economic laws are given, and applications of higher mathematics in economics are considered.

The manual contains separate sections, which are devoted to the basics of work in the latest version of the mathematical software package Mathcad-14, tasks for independent work, modular control tasks, test tasks.

The presented material belongs to the sections: differential calculus, functions of many variables, integral calculus, series, elements of probability theory and mathematical statistics.

A feature of these manuals are practical tasks that visualize abstract concepts with specific examples. These tasks are of the following types: 1) tasks that precede the study of new mathematical concepts and create a problem situation; 2) tasks that promote better understanding and assimilation of new concepts; 3) tasks that form the skills and abilities to apply the theories in related disciplines; 4) professionally oriented, which are close in content to special disciplines and instructive areas of possible application of the studied.

The following conditions contribute to the consolidation of information, increase its capacity, based on the principles of integration and optimal visualization: the complexity of the theoretical material, the use of the same symbols in related disciplines and the algorithmic method of presenting the material. In this case, the external conditions of material compaction are the modularity of construction (arrangement of modules around fundamental mathematical concepts) and the use of new information technologies.

The didactic complex is characterized by multifunctionality and variability. The textbooks contain didactic materials that go beyond state standards. The selection of educational material and its structure allows it to be successfully used by students with different levels of training.

As already noted, the training material is characterized by complexity. In the textbooks of the didactic complex, this principle is widely used in cases where the availability of teaching material does not suffer.

The next feature is flexibility as the ability of the didactic complex to respond quickly and mobile to adapt to rapidly changing external conditions, to manage the learning process with the transition to self-learning. Because the content of the course is consistent with the method of modular teaching - it allows it to vary and refine taking into account the specifics of the chosen profession, student requests, the peculiarities of local labor markets, the capabilities of the educational institution and others.

Textbooks, their structure and construction have allowed the widespread use of a system of concentrated learning, which requires a holistic approach to knowledge acquisition, ie certain organizational forms of learning.

We see the most effective implementation of this complex on an activity basis, which involves the use of various forms of work. For example, uniting students in permanent or temporary groups and in the form of a game modeling elements of future professional activity. The training course may include several types of activities (invention, production, research, design, etc.).

The complex has a practical and creative focus and aims to take into account the personal qualities of students.

For professionally-oriented disciplines, the complex can most effectively perform the functions of an orientation course, which should develop students' understanding of the relationship with other disciplines, the specifics of the profession.

Here is an example of didactic elaboration of the material, within the mentioned complex, a course of higher mathematics. We found that the dynamics of development of any economic system is complex, multifaceted, contradictory, so the research uses mathematical modeling. Such models help to identify system-forming factors and on the basis of knowledge of their laws - to describe the relevant processes. A feature of modeling cycles of economic dynamics is the provision of formalized functions of discrete form. Taking the continuity of time, in the course of the analysis of any process, however, discreteness is artificially created: the process is divided into segments at the level of size - years, quarters, months, weeks, days. So there is a time series, ie several or many numerical quantities for different, but equal in size periods of time. Mathematical description of such cycles allows to solve a number of important problems:

- study of internal processes of the phenomenon;
- study of the behavior of cycle parameters under the action of variable values of factors;
- use of data in current and future plans;

- construction of a system of models, consistency and synchronization of its information with the process control system.

In order to formalize such cycles, a number of mathematical methods are traditionally used - trend selection, spectral analysis, difference transformations, regression and interactive analysis, the method of calculating the numerical characteristics of random variables.

At the same time, in recent years, among scholars studying long-term trends in economic dynamics, there is growing support for the need to develop more sophisticated methods for studying periodic oscillations. The need to use new mathematical models, which are similar to those already common in the study of dynamical systems in physics, biology, ecology, psychology, linguistics, is recognized in many works on the theory of long waves. For example, in the study of macroeconomic dynamics, a system of Volter-Lotko differential equations was used, which describes the "predator-victim" model in ecology [18]. It is interesting primarily because the studies of these scientists were the beginning of the so-called mathematical ecology. In this model, the change in population size is fluctuating, which is often observed in nature.

Cyclic or oscillatory dynamics finds its correspondence in most real processes. Currently in economic research appear investment, business and technological cycles, employment cycles. In economic theory, there are cases when classical and neoclassical models of economic growth lead to cyclical solutions. Within these models can be explained fluctuations in major macroeconomic changes: national income, capital, employment.

In view of the study, we have expanded the sections - "Differential equations", "Series", including topics - "Systems of ordinary differential equations. Voltaire-Lotka model" and "Trigonometric Fourier series".

Considering the concept of the function of one variable as a basic one, we do not limit ourselves to its study by methods of differential calculus, but immediately move on to solving professionally-oriented problems, using their inherent records and notation. In the next step, we draw analogies with the concept of the function of two, three and many variables, enhancing the effect of visual images, using the mathematical software package Mathcad.

In this case, implementing the principle of professional orientation, during the training of students of the Faculty of Agronomy of VNAU, we draw parallels with the concepts used in cartography and geodesy. The ability to automate calculations and data visualization in the Mathcad environment (Fig.1,2) gave the lesson a creative nature. At almost all stages, students had the opportunity to make their own "discoveries", to see a graphic illustration of theoretical calculations. This is illustrated by the following examples.

Example 1. Suppose that the function of demand for goods A is $x_1 = f(p_1, p_2) = 25 - 2p_1 + p_2$. Where p_1 - the price of goods A, p_2 - price of goods B.

Find the partial exponents of elasticities for $p_1 = 3$, $p_2 = 1$.

Solution. We have: $E_{11} = \frac{-2p_1}{25 - 2p_1 + p_2}$, $E_{12} = \frac{p_2}{25 - 2p_1 + p_2}$. For $p_1 = 3$, $p_2 = 1$, obsessed $E_{11} = \frac{-6}{20} = -0,3$.

This means that when the price of a good A increases by 1% and the price of the good B remains the same, then the demand for the good decreases by $0,3\%$. Similarly, $E_{12} = \frac{1}{20} = 0,05$ that is, if the price of goods B increases at 1% a constant price of goods A demand for goods A increases by about $0,05\%$ (Fig. 1).

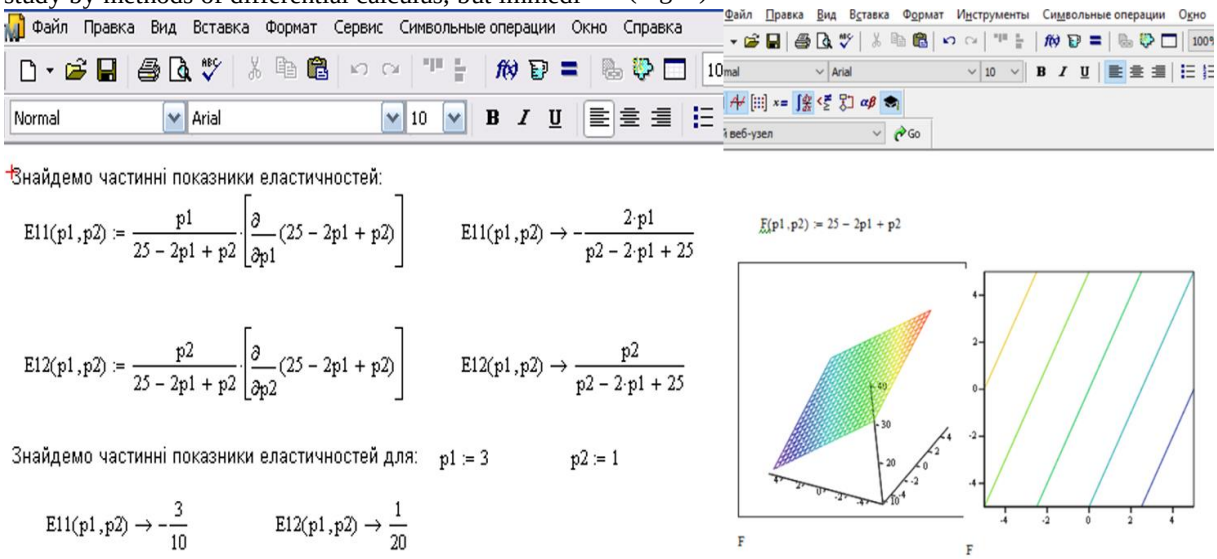

Fig. 1 Visualization of the data to example 1

Example 2. Let two types of goods *x* and *y* be made. Their prices are respectively $p_1 = 8$,

$p_2 = 10(\text{ум.од.})$, and the cost function $S = x^2 + xy + y^2$. Find the maximum profit.

Solution. Write down the income function $R = 8x + 10y$. Profit $\Pr$ is the difference between income R and expenses S. If we write the profit function: $\Pr(x, y) = 8x + 10y - x^2 - xy - y^2$.

The resulting function is a function of two variables for which the maximum must be found. Find the stationary points: from the condition of local extremum $\frac{\partial \Pr}{\partial x} = 8 - 2x - y;\ \frac{\partial \Pr}{\partial y} = 10 - x - 2y.$

We obtain a system of equations: $\begin{cases} 2x + y = 8, \\ x + 2y = 10. \end{cases}$ the solution of which is a pair of numbers $(2;4)$. Thus the stationary point has coordinates $(2;4)$.

Therefore, the point $M(2;4)$ is suspicious of the extremum. $A = \frac{\partial^2 \Pr}{\partial x^2} = -2 < 0$, $B = \frac{\partial^2 \Pr}{\partial x \partial y} = -1$, $C = \frac{\partial^2 \Pr}{\partial y^2} = -2$, a $AC - B^2 = 3 > 0$ - maximum at this point. $\Pr_{\max} = \Pr(2;4) = 28$.

(Fig. 1).

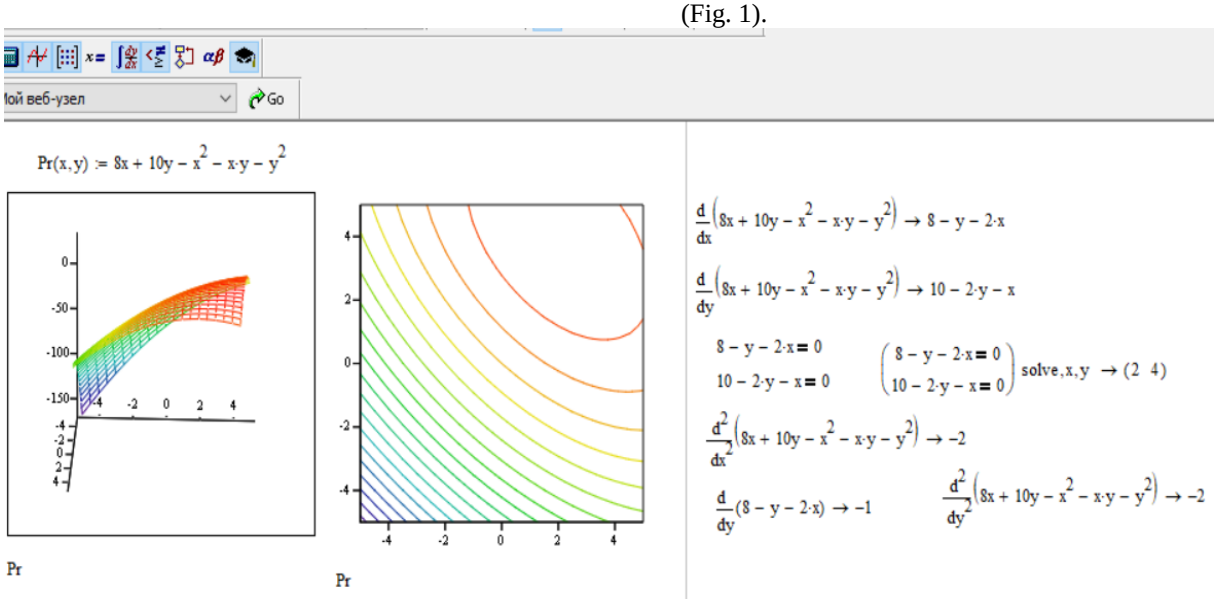

Fig. 2 Visualization of the data in example 2

It is important that in the process of preparing students in the All-Ukrainian research and training consortium, the need to use mathematical methods to students have the opportunity to demonstrate not only teachers but also specialists of research farms during excursions and training practices. In this case, it is the need for geodetic calculations during professional activities in the agricultural sector. In senior courses, students can directly apply the results and test them in practice.

But already in the first year we establish integration relations at the level of abstract and professionally-oriented concepts: the graph of the function of two variables (some surface) - the terrain (a set of irregularities of the earth's surface); level lines, the equation of which, where (lines of intersection of the graph with parallel planes) - horizontal (closed curved line connecting points with the same height). We emphasize that the horizontal can be represented as follows from the intersection of the earth's surface with the horizontal plane. Using the Mathcad system, we compare the types of digital terrain models with the corresponding graphs of functions.

At the next stage, considering the concept of extremum, we make a mathematical model for solving optimization problems, using methods of differential calculus to study the function of one and two variables, and transfer them to solve professionally-oriented groups of problems.

Experiments to involve students in the situation of learning through analogies, generalizations, combining basic knowledge in holistic theories have shown that the development of professional readiness of future farmers most effectively contributes to the acquisition of mathematical knowledge: a) in conjunction with the algorithms of their applications; b) by synthesizing them with systems of general scientific and professional knowledge; c) for the systematic implementation of information technology in the educational process.

At the same time, it is important to realize the integrative role of acquired mathematical knowledge in the theory of processes occurring in nature, as recent trends are to strengthen the integrative role of mathematics in science, in the formation of new areas of scientific knowledge that enrich agricultural practice.

Thus, the ability to identify basic methods of analysis of phenomena ensures success not only in the development of new technology, in the development of new technologies, devices in future professional activities. The system of such influences is characteristic of the assimilation of other general scientific knowledge, which indicates the general didactic nature of the conclusion about the influence of the process of assimilation of mathematical knowledge on the readiness for professional activity.

Based on the above, we consider the mathematical competence of farmers as an element of professional

innovative educational process, organized on the basis of mastering systematic mathematical scientific knowledge and methods of implementing mathematical methods in agriculture which involves mastering the content of mathematical disciplines based on methods, forms and teaching aids. promote the development of intellectual skills, analytical thinking, form communicativeness, reflexivity and a creative approach to solving problems as close as possible to future agricultural activities.

Thus, the process of teaching mathematics as one of the leading general scientific disciplines should be focused on the formation of the whole structure of readiness, expand the future specialist's understanding of the integrative role of mathematics in the formation of new general scientific directions, deepen methodological training and understanding of general scientific methods.

At the same time, it should be remembered that agricultural educational institutions of the research type create new opportunities for the integration of training. In the All-Ukrainian research and training consortium, co-founded by VNAU, students have the opportunity to directly apply fundamental knowledge, theoretical developments and test in practice in research farms.

Thus, the study of the latest trends in economics is reflected in the content of the mentioned didactic complex of training future professionals, namely in the study and mastery of innovative approaches to modeling cyclical processes in economics.

Conclusion. Thus, the set of principles of fundamentalization and professionalization, integrity and subject differentiation, continuity, scientificity and accessibility, in their interaction, is an effective tool in resolving and resolving all major contradictions that arise during the introduction of integrated mathematical content of education in training future professionals.

The proposed approach significantly optimizes the process of professional training, because, there is a consolidation of its content, increase information capacity, there are ample opportunities for flexibility and variability of learning.

Didactic complex of educational and methodical support of integrated mathematical training of specialists as a basis of their professional training.

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