MODERN EDUCATIONAL TECHNOLOGIES IN THE TRAINING OF SPECIALISTS IN THE AGRICULTURAL SECTOR DURING THE CRISIS

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Scientific monograph

IZDEVNIECĪBA BALTIJA PUBLISHING

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Scientific monograph

Riga, Latvia
2023

UDC 37(08)
Mo045

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|---|---|
| **Title:** | Modern educational technologies in the training of specialists in the agricultural sector during the crisis |
| **Subtitle:** | Scientific monograph |
| **Scientific editor and project director:** | Anita Jankovska |
| **Authors:** | Anatolii Biliuk, Olena Diachynska, Oksana Voloshyna, Olena Dzhedzhula, Viktor Dzis, Olena Diachynska, Viktor Dubchak, Elvira Manzhos, Elena Levchuk, Natalia Havryliuk, Lyudmila Novitska |
| **Publisher:** | Publishing House "Baltija Publishing", Riga, Latvia |
| **Available from:** | http://www.baltijapublishing.lv/omp/index.php/bp/catalog/book/310 |
| **Year of issue:** | 2023 |



Modern educational technologies in the training of specialists in the agricultural sector during the crisis : Scientific monograph. Riga, Latvia : "Baltija Publishing", 2023. 340 p.

ISBN: 978-9934-26-298-2

DOI: https://doi.org/10.30525/978-9934-26-298-2

The research is devoted to the urgent problem of formation of professional and innovative competence of future agronomists in the crisis conditions of the higher education system of Ukraine due to the consequences of the pandemic and the war. Modern approaches to the design of the content of education under martial law are highlighted. The structure, main trends and features of forms and methods of training specialists with a focus on new problems and challenges are revealed.

The publication is addressed to heads of higher educational institutions, pedagogical and research workers.

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# FUTURE AGRARIANS' PROFESSIONAL-INNOVATIVE COMPETENCE AORMATION OF A MATHEMATICAL COMPONENT IN CRISIS CONDITIONS

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DOI: https://doi.org/10.30525/978-9934-26-298-2-6

**Abstract**. Restoration and establishment problems of the educational process in higher education institutions, ensuring the sustainability and continuity of vocational education in war conditions are considered. The article proves the leading role of future farmers' mathematical component of vocational-innovation competence. Its formation ways in crisis are demonstrated for deepening integration ties in the science-education-production system. Professional and competency model ideas of teaching mathematical disciplines of agrarian profile, which are based on deep integration with a professional-oriented cycle and implemented by introducing remote forms and modern information technologies in the educational process on the basis of its information and computer support, are substantiated. It is established that the idea realization of a professional-competency approach will allow the future specialist to perform qualitatively fulfilled tasks in modern high-tech and intellectual professional professional environment. Future farmers' mathematical component levels of professional and innovative competence of have been developed. The need to introduce remote forms in the professional training of specialists is substantiated, based on the experience of training obtained during coronavirus infection. The interaction problem and integrity of three components is considered: organizational forms, didactic process and teachers' qualification. The essence of "professional competence" and "mathematical competence" as components of future farmers' innovative competence is considered. It is

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argued that mathematical training is a significant professional competence component. The need to reorient the vocational training system for education fundamentalization and widespread implementation of computer technologies practical-oriented information. It is proved that the process of innovative competence formation of specialists requires the transformation of mathematical courses. One of the important problems is the development, use and implementation of information technologies in future farmers' mathematical preparation. The impact of mathematical modeling on the readiness formation to solve professional tasks as a component of future farmers' innovative competence is analyzed. The introducing mathematical modeling expediency on the basis of Mathcad in the process of future farmers' professional competence formation is proved. Didactic learning principles are analyzed, which, by regulating practice, help combine the pedagogical process. On this basis, the implementation technology of the Mathcad system in the study of mathematical disciplines in agricultural establishments of higher education is modeling. It is highlightes in what way the generally didactic principles of clarity, science, systematicity, accessibility, consciousness, integration, professional orientation, humanization, advanced learning in the process of using this technology are specified. It is argued that the illustrative and demonstration of practical significance of fundamental concepts contribute to the optimization process of future farmers' mathematical preparation. The theoretical justification has been carried out and developing experience, using and implementing future farmers' mathematical preparation technology on the basis of the use of Mathcad mathematical system. Basic didactic requirements are determined and the impact of technology on such mathematical training components as motivational-value, cognitive, operational-activity, communicative. The main mathematical models are highlighted in mathematical courses. Mathematical modeling examples based on Mathcad are given. Introducing mathematical modeling advantages in the process of professional specialists training are demonstrated. It is concluded that the novelty presented with the help of MathCad system of educational material, illustrative and practical significance of the studied concepts and concepts shapes students' motivation and creates a positive emotional background. This, in turn, helps to intensify learning, which is closely related to the formation of persistent cognitive interest.

Mathcad system usage in the process of studying mathematics in agricultural establishments of higher education is a method that allows you to take a fundamentally new approach in students' teaching, namely: it has at its basis the research nature of students' activity. It is a creative laboratory that allows students to study new objects comprehensively, to distinguish patterns and to formulate generalized statements based on their own observations, which promotes creative, critical and independent thinking development; allows students to concentrate on solving meaningful tasks, to reach the level of concepts, concepts, to consider many examples in a short time; forms future specialists' necessary level of knowledge, the ability to analyze, compare, summarize, process available information, associate it with the issues that are studied, thus, forming a mathematical and information culture; teaches promptly, taking into account the fast variability of tasks, find the necessary information and effective ways of solving them; based on broad communication, erases boundaries and distances, attracts world mathematical and information culture; promotes development and self-education skills.

## 1. Introduction

*The subject of the study* is future farmers' professional training.

*The purpose of the study* is to consider the problem of innovative competence formation of future agricultural professionals in the process of mathematical training. To prove theoretically and develop the technology of future farmers' mathematical training aimed at modern requirements meeting of agricultural production based on mathematical modeling in the Mathcad system.

In this article, we aim to prove the leading role of the mathematical component in the formation of innovative competence of future farmers. We want to demonstrate ways to form it in crisis, using modern educational technologies. In particular, these are remote and mixed forms of training, using Mathcad software for mathematical modeling.

Our goal is also to prove the basic principles of future farmers' mathematical competence formation, using the functionality of the consortium and demonstrating that in this approach of mathematical disciplines transformation is due to the creation of appropriate information environments, which are tasks of our research.

*Scientific novelty.* Theoretically proved the feasibility of introducing mathematical modeling on the basis of Mathcad in the process of future farmers' innovative competence formation. On the basis of specifized generalized principles, the relevant technology implementation in agricultural establishments of higher education is demonstrated. The main mathematical models are highlighted which are appropriate to consider in mathematical courses.

*Objectives of the study:*

1. Consider the essence of the concepts of "professional competence" and "mathematical competence" of future farmers.

2. To argue that the process of fundamentalization and informatization of professional knowledge requires the transformation of mathematical courses through computer simulation.

3. To prove the introducing mathematical modeling expediency on the basis of Mathcad in the process of future farmers' innovative competence formation.

4. To carry out theoretical substantiation of implementation technology of the Mathcad system in the mathematical disciplines study in agricultural establishments of higher education.

5. To consider how the generally didactic principles of clarity, science, systematicity, accessibility, consciousness, integration, professional orientation, humanization, advanced learning in the process of using this technology are specified.

6. To present the developing experience, using and implementing future farmers' mathematical training technology based on the use of Mathcad mathematical system.

7. To identify the basic didactic requirements and to investigate the impact of technology on such components of mathematical training as motivational-value, cognitive, operational-activity, communicative.

8. To highlight the basic mathematical models that are advisable to consider in mathematical courses.

9. To demonstrate the advantages of introducing mathematical modeling in the professional process of of specialists' training.

*Research methodology:* literature systemic analysis; conceptual apparatus research; modeling; pedagogical experience generalization; observation, data analysis, conversation, testing of students, method of diagnostic control works; qualitative and quantitative analysis of research results.

## 2. Formulation of the problem

Currently, new challenges caused by the coronavirus pandemic, a full-scale war, which are facing the agricultural sector of the Ukrainian economy. Therefore, there were significant obstacles in reorientation to the European economic system. At the same time, the solution of food provision of the country and the whole world involves the introduction and use of the latest intellectual technology. This requires the presence of fundamental and universal knowledge of specialists. New requirements for the competence of future specialists are set. Therefore, in today's crisis, there is a need to restore and adjust the educational process, ensure the sustainability and continuity of vocational education. The above provides for the introduction of innovated innovations and transformations in higher educational institutions and the introduction of new progressive methods of formation of students' scientific knowledge.

At the same time, universities have received greater freedom of choice, they have the opportunity to choose a strategy of traffic on their own. In order to deepen integration in the system of science-education-production, we are talking about the transformation of agricultural education institutions in Ukraine and the creation of modern university complexes on their basis. A striking example is Vinnytsia National Agrarian University, which conducts a course on development in the direction of creation of an agricultural educational institution of a research type.

It is important that in crisis, the independence of the choice also applies to the educational process: development of normative documents, formation of content of training courses, selection of forms and methods of teaching. In particular, flexible mixed forms of training specialists are justified, which provide for alternation of eye and remote. At the same time, the training of agrarian specialists curriculum has a tendency to increase the share of independent work in natural and mathematical courses. This approach seems to have its advantages: hours for professional-oriented training are released, since students are more motivated to study the relevant disciplines, and immediately the prospect of using the knowledge gained is immediately visible. Accordingly, in order to preserve traditional, sufficiently voluminous programs, such as mathematical disciplines, they are taught with greater intensity. Such a methodical technique is not always justified, since students have significant gaps in the basic course of school mathematics.

But the search for ways to introduce a new paradigm and, accordingly, new education models is not limited to the transition to the professional-oriented disciplines predominance. Important thing in this process is to achieve fundamentally new goals of education, which in turn determine the search for new forms and methods of the educational process organizing.

The current state of agrarian science and practice, dynamic progress in the agricultural sphere, increasing the volume of new information under the exponential law sharply reduces the share of knowledge gained by the student at the university compared to the one he needs for his professional activity. Therefore, the value of preparation in the agricultural institution of higher education is not only in obtaining relevant only for a short time of knowledge, performing a limited range of tasks, but first of all in the intellectual potential of specialists, mastering them with the fundamental bases of knowledge and ways of thinking, on the basis of which innovative knowledge can be produced Developing professional competencies throughout his career. After all, the indirect influence and the "delayed" nature of the utility of fundamental studies do not make them less relevant. Therefore, current employers in the agricultural sphere are primarily interested in the potential of the future specialist, his ability to selfdevelopment and the ability to educate (search for information, its perception, memorization, use). Not surprisingly, recently interviews in agricultural companies, candidates for positions offer tests for determining the coefficient of intelligence (IQ), research qualities, operations of ways of cognitive activity, possession of techniques of logical thinking, flexibility of thinking.

Therefore, students of agricultural higher education institutions, which are mainly from rural areas, where mathematical training is weaker, there are problems with access to Internet communication, it is difficult to achieve the results in the university in a few years of study at the university.

It is consistent with the idea that the formation of students' intellectual skills, in particular future agricultural professionals, occurs in the process of studying higher mathematics. In this context, the role of fundamental knowledge, which is the basis of mathematical ones, increases.

Mathematical knowledge expands the boundaries of narrow professional activity, giving it creative features: promotes the development of a universal method of mathematical modeling, the ability to predict the phenomena under study, to use a system and structural approach in their analysis, promotes the development of intuition, gives logical completeness of judgment.

In our opinion, in modern conditions a special place in higher agricultural educational institutions should be occupied by mathematical training, in fact invariant for the professional training of different profile specialists. Its components (linear algebra, analytical geometry, mathematical analysis, probability theory, mathematical statistics), being an integral part of agrarian education, deepen students' understanding of the place and the importance of their profession in professional innovation, stimulate possibilities awareness of using mathematical knowledge as a means of professional tasks solving, social prestige of the profession, that is, contribute to the professional outlook deepening.

Therefore, the mathematical competence formation, as a component of vocational competence, which will allow the future specialist to perform the tasks in modern crisis and at the same time high-tech and intellectual professional environment.

The educational development priority in crisis is the introduction of modern information and communication technologies, which ensure further improvement of the educational process, the efficiency of education availability, the training of future specialists for professional activity in the information society.

The Second International Congress of UNESCO recommendations for technical and vocational education aimed at its advance development are the implementation and active use of new information technologies in educational processes.

This is appropriate because modern youth have grown in digital society and has a greater influence of technology than older generation. Young people spend a lot of time with mobile devices, admire video games, read books rarely. Through the lens of information technologies, modern youth mostly perceive the universe, finds an updated desire for knowledge, education, culture, creative and work. It is consistent with the fact that "Google generation" has been involved in innovative technologies since childhood and has modern approaches to information, it has no experience in existence. Currently, the Internet is the most popular source of information from others. Thus, according to the report of the non-profit organization online computer Library Center, about 83% of students start collecting any information from the search engine and only 2% pay attention to libraries or real books. Students prefer digital interactivity in everyday life, so traditional educational technologies seem boring and uninteresting. And this has a detrimental effect on the educational process.

Therefore, information technologies are an integral part of the young person. This is due to the nature of the process of cognition as a reflection of a person of objective reality. Therefore, it is necessary to give preference to learning, which would provide for the peculiarities of the worldview of modern youth. And the tasks of educators at the present stage, having switched to the "territory of youth", make the learning process thoughtful, rational, comfortable, for which the student feels their success and intellectual capacity.

At the same time, graduates of agrarian universities and colleges lack practical knowledge, skills and competencies, their education is too theoretical.

One of the promising ways to resolve these contradictions is the deepening of integration ties in the science-education-production system. Namely – the transition to research types of higher agricultural educational institutions and the creation of modern university complexes on their basis.

Ukraine has ancient agricultural traditions. 70% of its territories are all the agricultural sector. Having a third of the world's black soil, it has high potential. However, the war showed both the importance of food security and seriously influenced agrarian relations in Ukraine. In 2022, the country recorded a physical reduction of acreage by at least 25% of the usual volume, destruction and the need for complete restoration of 15% of the agrarian sector, locking ports, violation of logistics routes.

Therefore, priority tasks are export logistics development, crops storage, funding for the agrosphere and lending access. The agricultural sector post-war development involves increasing its competitiveness and promoting rural development on a steel basis in accordance with EU standards and international standards [1].

This requires the use of high level agrotechnologies. Nowadays, multifunctional energy-saving agricultural machinery, high-scale accuracy technologies, genetically engineering-modified organisms, biologically active feed additives, animals for animals and more are widely used in the world. Production activity at agricultural enterprises includes control and satellite control systems, remote diagnostics through the Internet, agricultural machinery is equipped with an interface that allows you to carry out electronic data transmission of ISOBUS. This, in turn, requires the appropriate level of agricultural specialists. There is a need to reorient the professional training system at all stages of educational fundamentalization and widespread implementation of practical-oriented information computer technologies.

This gives the mathematical preparation importance, as one of the fundamental ones, which primarily forms the skills of abstract thinking, analysis and synthesis, which are future farmers' innovative competence component.

Now there is a new function of the educational institution in the process of providing educational services – the formation of an innovative competence of professional educational model of specialists. It is a system of motives, knowledge, skills, personal qualities of agrarian, which ensures the efficiency of using new technologies and in the professional field technology.

In order to ensure the further development of the agro-food sector, stimulating the creative process, the competent choice of innovative priorities in the field of high importance is the introduction of new technologies [2]. Due to the automation and informatization of the process of agricultural production, intellectualization of labor in the fields of agroindustrial complex is observed [3].

It is also worth noting that in the globalization processes conditions, future specialists' professional activity is characterized by dynamism, complexity and uncertainty of conditions. Informatization and fundamentalization of knowledge gives relevance to such components of professional competence of the future agrarian as the ability to think analytically, to solve forecasting tasks through software products, to carry out economic and mathematical modeling with the use of modern information systems, to use computer technologies of data processing to solve professional problems [4].

Today, it is the results of mathematical modeling of real processes that generate the most progressive areas of development in science and technology. Therefore, the mathematical model concept plays a fundamental role in the specialists training. This is explained by the great interdisciplinary function of mathematics, because many laws are not formulated in a descriptive plan, but in the language of mathematics. The modern agrarian specialist must use linear programming methods, dynamic programming, game methods, statistics and probability theory.

In determining the mathematical competence, the PISA International Assessment Program is not specific mathematical skills, but more general skills that include mathematical thinking, mathematical argumentation, production and solution of mathematical problem, mathematical modeling, use of various mathematical languages, information technologies, communicative skills [5, p. 47].

Therefore, the innovative competence formation of future specialists of agricultural establishments of higher education, providing for professional and personal development integration, should be carried out with the mathematical modeling introduction, starting during the first year of study. Therefore, the preparation of an agrarian for the modern labor market involves the fundamentality of knowledge and the introduction of effective scientific-pedagogical and information technologies using appropriate educational and methodological and informational software [6].

Therefore, at the state level, the task is to lead to the introduction of a "advanced system of training of specialists, the development of scientific training courses, orientation of students' independent work on specific tasks of production" [7, p. 6].

The system of agricultural education is about the formation of an open information and educational educational environment [8].

At the same time, it should be remembered that young people are very susceptible to the development of informatization. Information technologies are an integral part of its formation. This is due to the nature of the cognition process of as a reflection of a person of objective reality. Through the prism of information technologies, it mostly perceives the universe in a new way, finds an updated desire for knowledge, education, culture, creative and labor activity

Therefore, all the components of the process of training of specialists should be reoriented both on the needs of the agricultural industry and personal needs and features of the worldview of modern youth.

## 3. Analysis of recent research and publications

The importance of mathematical training, as a component of innovative competence of future specialists, is emphasized Silenok V., Skatetskiy O., Fomkin A., number of works follow the idea of a research approach using information technology.

The problem of formation of professional and mathematical competence of specialists of different profile of higher educational establishments is considered in the studies of Averno O., Blokhina R., Zhukova G., Ilarionova G.

Some authors interpret the concepts of mathematical competence as the ability to see and apply mathematics in real life; understand the content and method mathematical modeling; The ability to build a mathematical model, explore it by mathematics methods, interpret the results, evaluate the calculation error.

In the development of theoretical and methodological aspects of the problem, scientific and methodological studies for us were important for us to improve the methodology of teaching mathematics of students-ecologists (N. Gavrish, T. Emelyanova, O. Poltavskaia, T. Yarho).

In our study, we relied on the works of scientists who were engaged in the study of the mathematical knowledge formation problems and skills (M. Burda, M. Zhaldak, P. Erdniiev, M. Ignatenko, T. Krylov, M. Metelsky, Z. Slepkan, and A. Stolyar, I. Teslenko, M. Shkol, N. Shunda).

Significant role was played by some aspects of the problem of intellectual skills formation in the process of studying mathematics, covered in the works of M. Ignatenko, I. Pasichnyk, Z. Slepkan, O. Khashechnikova.

These authors distinguish the following types of intellectual skills: analysis, the main issues selection, comparison, generalization, systematization, definition and the concept explanation, concretization, proof, modeling and forecasting.

In their research, they conclude that it is advisable to use a system of exercises and tasks in the process of higher mathematics studying for the gradual development of students' intellectual skills in the process of studying higher mathematics.

The knowledge and abilities of a specialist acquire values only if they are optimal. It is indicated that if traditional intellectual abilities can be considered as indicators of mental mechanisms for information processing, then cognitive styles (control) are mental mechanisms for managing these processes of information processing.

The literature review shows that in studies concerning mathematical systems in training courses introduction, the authors mainly touch the target and content-educational part of it. The goals of information technologies in the educational process, the training content, developed individual didactic materials have been proved [9; 10; 11].

Psychological and pedagogical requirements for the introduction of computer-oriented systems are also considered the process of students' preparation in order to increase the mathematics learning effectiveness, methods of studying the effectiveness of computer use in the educational process [12].

There is a positive experience in computer support using for mathematical courses and in establishments of higher education [13; 14].

Within the framework of our study, the experience of using the MathCad system to solve different classes of mathematics problems, which have both abstract and applied nature [15; 16].

However, the study devoted to the specific didactic foundations of the Mathcad system in the mathematical preparation of the future agrarian has not been completed. We consider them as a set of principles, goals, objectives, techniques, organizational forms, methods, techniques, means of teaching and ways of evaluating the results of students' educational activity.

However, P.K. Pakhotina in her study emphasizes that "there is a lack of a systematic approach to the formation of information and communication competence of students of agrarian specialties in universities" [17, p. 2].

With regard to mathematical specialists' training, scientists get into the field of view of theoretical issues related to the use of mathematical systems in the teaching of mathematical disciplines of students of a wide range of specialties [18], as well as developed individual methodological works aimed at solving highly specialized tasks. Fragrance, a mathcad learning experience is presented for the non-isothermal piston reactors development [19], Jigsaw Cooperative Learning of Multistage Counter-Current Liquid-Liquid Extraction Engineering Studies [21].

O. Novozhylova emphasizes that when teaching mathematics is a necessary economic orientation, which includes the use and construction of economic and mathematical models on the basis of real data [22].

In this sense, S. Rakov understands mathematical competence, as "the ability to see and apply mathematics in real life, to understand the content and method of mathematical modeling, the ability to build a mathematical model, to explore methods of mathematics, to interpret the results, to evaluate the calculations" [23, p. 15].

In his research, K. Rumyantsev concludes that the use of modeling tools in solving creative professional tasks allows students to be interested in the subject, to teach themselves to analyze, to observe, to establish relationships and relationships between objects of the material world [29, p. 11].

However, despite the fact that the mathematical model of the process under study or phenomenon in the economy always generalizes its abstract reflection, the mathematical apparatus that is usually used is quite enormous. This is a significant obstacle to enhance the applied mathematics in younger courses.

In our opinion, one of the effective ways to eliminate the outlined contradictions is the informational technologies introduction.

In this sense, scientists emphasize the need to transform the relevant educational components at the appropriate level of higher education within the specialty, including mathematical courses.

O. Semenikhina reveals the need to shift the accents in teaching methods for the formation of critical attitude of students to the results obtained by knowledge in the process of teaching mathematics on the basis of electronic educational resources [25].

D. Kasatkin substantiated, constructed and experimentally tested the preparation model of future economists for the use of information and communication technologies in professional activity. The training content of economic informatics, taking into account the thematic content of special disciplines, has been developed [26].

Currently, Mathsad, Matlab [28] mathematica and maple in Windows [27] are now most famous and widespread systems.

To solve different classes in mathematics of applied nature, the attention of users is attracted by the Mathcad system [21].

At the same time, the problems of implementation and use of mathematical systems in mathematical disciplines at certain stages of preparation (lecture, laboratory classes, in the preparation of course and diploma works) are mainly considered [28].

A series of manuals and directories created by a wide range of students of engineering and economic specialties, whose authors do not claim to replace specific mathematics courses, but are complementary when choosing the optimal calculation methods [29], selection of professional-oriented tasks [30], creating illustration provisions [31].

For example, Makarov Y.G., dedicated to working in the 14th version of Mathcad, contains a list of examples of solving engineering problems.

However, there are guides that have a format of a mathematics training course. Thus, “Mathcad economists” mathematics is a synthesis of traditional principles of teaching mathematics at the Economics Faculties of ZNO with the latest achievements of computer mathematics [32].

Therefore, it can be concluded that nowadays the problem of computer support for mathematics in agricultural establishments of higher education is quite relevant. There is a wide range of individual developments, reference literature and Internet sources. However, in the process of future farmers’ mathematical training, it did not become systemic.

The system of fundamental training of a modern agrarian profile specialist undoubtedly involves thorough mathematical education. After all, it is basic in the formation of logical, analytical, rational thinking, which is the basis for innovative professional activity. Mathematics is a universal tool that can describe real life dependencies and use them in the future for scientific forecasts of phenomena and processes.

Since mathematical activity is carried out in three directions: a mathematical description of research objects, the logical organization of mathematical material, the use of mathematical theories, it is obviously directly related to the professional tasks content.

At the same time, according to the traditional teaching methods, especially students of junior courses, they perceive mathematics as an abstract discipline that is not related to professional competencies. Typically, the course is remote from practical application, because mostly applications require cumbersome calculations and a complex mathematical apparatus. Therefore, students do not have an understanding of the role of mathematics as a general scientific tool for researching the surrounding reality. With no experience in studying professional-oriented disciplines, students do not see the connections of mathematics and special disciplines. This determines low motivation to study the discipline and has a negative impact on the learning outcome.

At the same time, the rational combination of traditional and new training technologies allows you to activate students' creative potential in the open educational system. The role of computer technologies is that they at a new level allow you to prepare the educational material and organize the learning process itself.

Modern information technologies have become an integral part of the life of modern society. First of all, it concerns young people. Teachers state that current students perceive information from electronic media more promptly. The necessary information they first get from the information flow through the Internet. At the same time, this information is often fragmentary, clogged, low quality. Therefore, the task of the teacher is to teach students to think critically and properly organize independent search work, using information technologies in growing streaming information.

Despite the availability of mathematical systems and reference literature, the complexity of their introduction in the training of specialists is the absence of appropriate technologies and didactic learning tools that would correspond to the specific discipline and the specialist's training.

Therefore, the need for theoretical justification and development of technology of mathematical preparation of future farmers based on the use of information technologies is quite relevant.

In our study, we take into account a number of features of agrarian establishments of higher education: training in an agricultural institution is a vocational training on the basis of general education, which was obtained mainly in rural areas; Higher agricultural school training is conducted mainly in educational institutions, which are simultaneously production and research complexes; Training is carried out in such forms of preparation, which are generally different from forms at previous degrees of education.

## 4. Mathematical component of professional and innovative training of future farmers

The process of becoming a new educational formation in crisis and professional activity intellectual saturation is accompanied by a number of transformations. It is a change in highly specialized training in the direction of problem-oriented with universal fundamental preparation, which provides opportunities for selfeducation, retraining, mastering new professions.

Judging by the above mentioned information we can make a conclusion that an important principle of future agrarian specialists' model building is the principle of pre-trial preparation compared to the pace of changes in professional activity.

We believe that the idea of a professional and competency model of mathematical disciplines for specialists training, based on deep integration with the disciplines of the professional cycle and is implemented by introducing modern information technologies in the educational process on the basis of its information and computer support, should be interpreted and used in preparation agrarians.

In the study of mathematics, different components of students' readiness for future professional activity are manifested. Solving mathematical problems requires the use of many mental skills: to analyze the given situation, compare data and the desired, design the simplest mathematical models, carrying out a thought experiment; synthesize by useful information selecting, organizing it; briefly and clearly, in the form of text, symbolically, graphically to draw up their thoughts; objectively evaluate when solving the problem, the results, summarize the results of the problem, explore special manifestations of the given situation.

All this requires deepening ideas about the basics of the mathematical education organization in agrarian higher education, which provides the knowledge and skills acquisition in unity with the "pivotal" properties development of personality. At the same time, it is important to disclose some general provisions of improving the professional training of specialists by means of scientific disciplines on the material of teaching mathematical cycle subjects.

Mathematics teaching 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 scientific and special knowledge for their application in practice; promotes understanding of the role of general scientific methods of cognition in solving production problems (analogy, generalization, abstraction, algorithmization, ascent from abstract to specific) contributes to the mastering of operations of heuristic, prognostic thinking necessary for professional activity; prompts transforming general methods of cognition into professional ones; awakens the desire to use the learned methods of knowledge in practice; Promotes the generalized methods assimilation of specific processes analysis in nature.

In this regard, the French mathematician A. Puancare 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 it, the mathematical images world is intertwined with the real world...".

Mathematics is an important subject for students of agrarian universities because it provides the basis for understanding and applying scientific and quantitative methods in the agriculture study.

Here are some specific fields of mathematics that may be especially relevant for agrarian students:

– statistical analysis and modeling are used to analyze data and forecast yields, weather conditions and other agricultural phenomena;

– differential calculus is used to study the speed of change and optimization. It is important for understanding concepts such as nutrient absorption and water circulation in plants;

– analytical geometry is used to study land use, topography and spatial structures in agriculture;

– linear algebra is used to analyze large sets of data and optimize complex systems, such as accurate agriculture;

– differential equations are used in the study of dynamic systems, such as population dynamics and weather forecasting. They are important for the sustainable management of resources in agriculture.

Mathematical knowledge cannot be divided into main and minor domains. They all bring their share in the formation of mathematical competences. The sequence of topics is traditionally determined by the discipline logics.

For example, by learning the theory of differential calculus, as abstract mathematical knowledge, students do not fully understand the described applied function of mathematics, which narrows the ability to master and to describe agronomic processes with mathematical models, the ability to develop professional thinking. This, in turn, reduces the value attitude to mathematics as the most important means of professional activity, forms a negative attitude to it, which impoveruses the whole system of professional orientations.

The study showed that students who learn each new section of mathematics as a new knowledge, not generalizing with the previously studied, do not see analogies in the structures and application of the theories under study, do not seek to distinguish basic knowledge, do not predict the possibility of its use. They are usually poorly aware of the mathematical generalizations essence, analogies, algorithms, because they do not understand, do not realize those influences that have mathematical methods on the formation and professional thinking development.

Conversely, understanding the professional activity new opportunities, which relies on a wider mathematical base, students later seek to master the theory of optimization, management, linear and dynamic programming.

Here is an example that we reach the demonstration.

Considering the concept of the function of one variable, as a basic one, we are not limited to its research by differential calculus methods, and immediately proceed to solving professional-oriented tasks, using their inherent records and designations.

In the next step, we draw analogies with the concept of the function of two, three and many variables, enhancing the effect of visual image, using Mathcad mathematical software.

In this case, in implementing the principle of professional orientation, in the preparation of students of the Faculty of Agronomy, we draw parallels with the concepts used in cartography and geodesy. The need to use mathematical methods is motivated by the need for geodetic calculations during professional activity in the agricultural sphere.

For example, we establish integration links at the level of abstract and professional-oriented concepts: graphics of the function of two variables (some surface)-terrain (a set of inequalities of the earth's surface); The lines of levels whose equation, where (intersection lines of graph with parallel planes) is horizontal (closed curve line, which connects points with the same heights). We emphasize that the horizontal can be imagined from the intersection of the earth's surface with a horizontal plane. Using Mathcad system, we compare the types of digital relief models with the appropriate functions.

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

Here are examples of such tasks.

Problem[1]. The dependence of agricultural production costs on the volume of manufactured products $q$ is recorded in the form $C(q)=\frac{1}{2}q^2$, the function of demand on the price looks like $Q(z)=40-2z$. Determine the volume of products that meet the maximum profit.

Solution. From the function of demand we express the dependence of the price on the volume of production. Given that profit

$P(q)=R(q)-C(q)=Z(q)\cdot q-C(q)$, we find extremums of the appropriate function. Using the standard research algorithm, we have a maximum of the appropriate function $q$ = 10. This is the optimal output.

Task 2. The enterprise produces two types of agricultural products in volume $x$ and $y$ units in accordance. Costs $C$ are a function $C(x,y)=x^3+y^3-3xy$. How many products of each type need to be produced to minimize costs?

Solution. According to the developed algorithm, finding the extremum of the function of two variables $C(x,y)=x^3+y^3-3xy$, we have a minimum at the point. Therefore, each type of product must be produced in the amount of $M_1(1;1)$ conditional unit.

The ecliptic, orbital coordinate systems, thus demonstrating the possibilities of using abstract concepts in the performance of tacheometric and theodolithic removal in geodesy. Due to the development of satellite geodesy, we also consider a geocentric spatial rectangular coordinate system, geodetic, topocentric, first and second equatorial coordinate systems.

Studies have shown that if a student distinguishes the topic of “second order curves” as the base in the section “Analytical geometry”, summarizes it in more complex cases of analysis of two dimensional processes Methods of their knowledge, transfer these skills to the assimilation of professional-oriented disciplines, combines methods of analysis of agronomic processes, producing prognostic thinking.

For example, considering the topics mentioned, among other second order curves, we consider the concept of ellipse in more detail, since it has its analogy in space-an ellipsoid of rotation used in geodesy. Making parallels with the concept of a geoid, which is not a correct geometric body, and is not expressed by the ultimate equation, we demonstrate the appropriate mathematical model in geodetic calculations, thus implementing the professional orientation principle.

In this case, we establish analogies between the characteristics of the mathematical concept of the ellipsoid and the earth's ellipsoid: the Great Semi-Sea – the Equatorial Radius (A), the Small Semi – Polar Radius (b), eccentricity $\left(\varepsilon=\frac{\sqrt{a^2-b^2}}{a}\right)$ – polar compression $\left(\varepsilon=\frac{a-в}{a}\right)$.

In addition, the use of information technologies open up new opportunities for a deeper study of the selected object characteristics. The use of infoomation technologies enhances the effect, adding clarity to the concept.

The use of Mathcad allows you to transition from abstract to a specific, clearly viewing the professional-oriented concepts of meridian and parallel, as traces from the intersection of the earth's surface with a plane passing through the rotation axis of the Earth and its perpendicular plane.

Mathcad is a computer software that allows you to create, organize and manipulate mathematical equations and expressions. It is often used in mathematical preparation of students of higher education because of the ability to perform complex calculations, create interactive visualizations and create documents of a professional nature.

The use of Mathcad in mathematical training of university students is best done in the following cases:

– solving complex mathematical problems. In this, random Mathcad can be used to perform complex calculations and symbolic transformations that can help students understand and solve complex mathematical problems:

– Mathcad can be used to create interactive visualizations of mathematical concepts, such as graphs and animations that can help students understand and explore mathematical ideas;

– Mathcad can be used to create professional documents, such as reports, presentations and work that can help students better convey their mathematical knowledge and results;

– cooperation and exchange. Mathcad allows you to cooperate and share mathematical work with other students and teachers that can help students receive feedback and assistance in their work;

– integration with other software. Mathcad can be integrated with other simulation and modeling software that can help students understand and apply mathematical concepts in the context of the real world.

Therefore, the ability to distinguish basic methods of analysis of phenomena provides success not only in the development of new technology, in the new technologies development, in future professional activity devices. The system of such influences is characteristic of the acquisition and other general scientific knowledge, which testifies to the generally didactic nature of the conclusion about the influence of the mastering mathematical knowledge process on readiness for professional activity.

In order to diagnose, we have developed future farmers' mathematical component levels of professional and innovative competence.

The initial (first) level of mathematical competence development is characterized by students' awareness of the mathematics applied aspect as a necessary base for successful learning of general scientific knowledge. Understanding this, students learn mathematical theories by generalizing the basic sections and algorithms, their annexes to solve mathematical problems. However, the role of mathematics as the professional and general scientific theories foundation is not yet deeply understood, as well as the possibility of the process of studying it in the development of thinking. There is no desire to improve their ability to generalize, to draw analogies, to build algorithms, to master synthesized methods of mental activity – mathematical modeling, creative intuition.

The average (second) level is characterized by an understanding of the basic mathematical bases of general professional and general scientific theories (for example, vector algebra, analytical geometry and geodesy, mathematical methods in the development of philosophical methods of cognition). Therefore, students learn knowledge by combining them into systems for constructing sign models of studied technical processes. This is due to changes in the ability to generalize, to make analogies, to build algorithms not only in the process of solving practical problems, but also in the process of obtaining theoretical conclusions. However, the role of mathematics as a foundation of professional knowledge is not deeply understood, as well as the influence of mathematical thinking on the formation of professional mental activity.

The high (third) level of competence is characterized by the realization that mathematical methods are not only a means of solving professional and general scientific theories. They are the basis of mathematical description and the agronomy processes analysis, ecology and other professionals of knowledge systems. Therefore, when learning each mathematics section, students distinguish basic knowledge as its elements, establish structural relationships between them, predict the applied functions of this knowledge in the studied theory in the field of processes occurring in nature; They find the optimal solutions of applied problems, using information technologies, predicting the result, often on the basis of heuristic intuition, that is, creative adaptation to unfamiliar situations. Students understand that developed heuristic thinking helps to effectively solve production problems in fleeting extreme conditions.

Based on the above mentioned information, we consider the mathematical competence of the agrarian as an element of a professional innovative educational process, organized on the basis of mastery of systematic mathematical scientific knowledge and mathematical methods implementation in the field of agrarian activity, which involves mastering the content that promote the intellectual skills development, analytical thinking, communicative form, reflexivity and creative approach to solving problems as close as possible to future agrarian activity.

By setting the task of mathematical competence forming of agricultural specialists, we proceed from the understanding that the peculiarity of mathematical competence of the agrarian as a result of professional training is that in comparison with other results of training it is:

– integrated result;

– through the use of information technologies, allows to solve a wide range of tasks (unlike the functional literacy element);

– exists in the form of activity, not information about it;

– agreed (related to a whole range of interaction objects);

– improved not by automation and transformation into a skill, but by integration with other competences – awareness of the common basis of professional activity, competencies are increasing, and the very method of activity begins without attracting additional internal resources (unlike skills);

– turns out to be consciously (as opposed to skills).

At the same time, information technologies penetrate the depths of any professional activity, affect the style, content and work methods, enrich it, expanding the scope. Therefore, the widespread use of new informational technologies in all areas of public life requires the knowledge sufficient for future specialists the confident use of such technologies in their own professional activity.

But, despite the fact that a large number of educational institutions have access to computer networks, established stereotypes often inhibit innovative development, make it impossible to perceive and introduce new ideas, new techniques and technologies. One of the reasons is that such training involves the presence of universal training of teachers who have modern pedagogical and information technologies, psychologically ready to work with students in a new educational and network environment.

Mathematical competence formation of students in agricultural institutions of higher education can be carried out by different methods, in particular:

– inclusion of mathematical concepts and competences in coursework and projects dedicated to agriculture. This can be done by giving students real examples of the use of mathematical concepts in agriculture;

– use of interactive and exciting teaching methods. This may include the use of virtual manipulations, interactive games and simulations, as well as online educational manuals and practical tasks to help students develop their mathematical skills;

– creating opportunities for practical training and experiments: it can include excursions, laboratory experiments and research projects that allow students to apply mathematical concepts and skills to real problems in the agricultural sector;

– ability to support students who may have problems with mathematics. This may include additional advice, tutoring and online resources that help students improve their mathematical skills and understanding;

– underline the importance of mathematics in a professional career can help students understand the relevance and real use of mathematical concepts and skills, that makes them more significant to them;

– technologies introduction in teaching mathematics, such as online calculators, graphic calculators, mathematics teaching systems based on artificial intelligence and virtual and augmented reality technology. They can give students an interactive, exciting and personalized learning experience;

– an interdisciplinary approach introduction, linking mathematical concepts to other subjects such as physics, biology and statistics. This will illustrate the wider use of mathematics in agriculture.

At the same time, the requirements of the information society for the graduates preparation of higher education institutions for the use of modern information and communication technologies come into contradiction with the lack of necessary educational and methodological support of such training. The level of scientific achievements of informative, psychological and pedagogical sciences contradicts with their reflection in the content, methods, forms and means of teaching. Unfortunately, few works are devoted to a thorough research on the problems of using information and communication technologies in vocational education. Until these developments are systematic and purposeful.

### 5. Peculiarities of distance learning of mathematical disciplines

Due to the war, violation of the country's energy system, the constant danger of missile firing is actualized by the problems of access to computer educational resources. Therefore, one of the areas of reform and development of modern higher education, which requires all-time information support, is remote and mixed learning, which is becoming more and more popular in the world. It is one of the promising learning technologies that is to solve the problem of personalized access to education during the war and plays a prominent role in the modernization of education.

Online training at the university, as a rule, includes courses completely online, with small guidelines or without personal instructions. This may include synchronous (real-time) or asynchronous (self-educational) classes, and can use a variety of tools such as discussions, video lectures and online quiz.

Blended learning combines online and personal training. This may include a combination of online course work, such as reading materials, quizzes and boards for discussions, personal meetings, laboratory work and other activities. Some mixed learning programs also use inverted class models where students study recorded lectures online before they come to a class for discussion and practical classes.

Hybrid learning is similar to blended learning, but this term is used more to emphasize that online components and personal components are more integrated and online part is more integrated with personal learning.

In general, online learning involves the student's course mostly or entirely online. Blended learning is when a student is a course with an online learning and personal learning course, and hybrid learning is when a student undergoes a greater degree of integration of online and face-to-face learning. In our opinion, hybrid learning will be relevant in the war conditions and energy crisis in relatively safe regions.

Scientists argue that the personal and telecommunication nature of learning – the main features of distance learning (V. Bykov, V. Kukharenko,

V. Treinev, E. Polate, P. Stefanenko, A. Khutorskoi, etc.). In our research, we adhere to the definition of V. Bykov's distance learning as providing educational services at a distance with new computer and communication technologies, universal, synthetic, integral, humanistic form of learning. Thus, the main purpose of distance learning is to provide the same educational opportunities for the population in any areas of the country with the help of information and telecommunications.

The forms of distance learning activities are diverse-from Internet conferences and web broadcasting of lectures to educational web forums and the like.

Many scientists determine the training course as a remote in which 80% of the educational material is based on the use of online technologies. Currently, the world disciplines are taught in the following formats: traditional teaching, network support courses, hybrid or mixed course, on-line course. Distance learning can take place within all types of didactic system.

During the war in Ukraine, educational technologies that have been tested during distance learning during the coronavirus pandemic are popular. In particular, learning management systems, such as Moodle, Canvas and Blackboard, allow teachers to create and distribute online content and evaluation, as well as track students' progress. Video conferencing tools such as Zoom, Google Meet and Microsoft Teams provide remote synchronous learning and communication between students and teachers. Online work tools such as Google Docs, Trello and Asana allow students to work together on projects and tasks in real time. Digital boards such as Jamboard, Explain Everything and Smart Board allow teachers to present and comment on real-time education. Interactive ebooks and multimedia resources such as Kahoot, Quizlet and Nearpod allow teachers to create interactive and exciting training programs. Gamified training platforms, such as Duolingo, ClassCraft and Kahoot, make learning fun and exciting through the use of game design elements. Virtual and Augmented Reality Technologies, such as Google Expeditions, VR Classroom and Class VR, provide exciting and interactive learning experience. Adaptive training platforms such as Knewton, Smart Sparrow and Aleks personalize the learning process for each student based on its progress and success. Social training platforms, such as Edmodo, Schoolology and Ning, allow students to communicate and cooperate with classmates, share resources and participate in discussions. Testing and surveys such as Google Forms, Survey Monkey and Kahoot allow teachers to create and conduct tests and surveys for formal and final evaluation.

There is also a powerful arsenal of educational technologies to study mathematics at the university. You can use the Texas Instruments, Casio, Desmos and Graphsketch graphics for complex mathematical calculations and visualization of graphs and data. They allow students to create and explore different types of mathematical functions and graphs, which can help them better understand mathematical concepts. Computer Algebra systems Maple, Mathematica and Matlab provide symbolic calculations and visualization capabilities in higher mathematics and engineering.

Software for interactive geometry, such as GeoGebra and Cabri, allows students to explore and experiment with geometric concepts through interactive visualization. Virtual and Augmented reality technologies (VR/AR) can be used to create the effect of immersion in learning and modeling of mathematical concepts such as 3D graphics. Online mathematics and resource textbooks provide students with a wide range of mathematical concepts and problems. The most popular are Khan Academy, Wolfram Alpha and Coursera, IXL and Mathwa,. They offer students interactive lessons, practical tasks and evaluations to help them improve their mathematical skills. Virtual manipulators as GeoGebra, Desmos and Fathom allow students to interact with mathematical concepts and explore different mathematical ideas, helping them understand and visualize complex mathematical ideas. Interactive mathematical games and simulators, such as Dragonbox, Prodigy and Math Blaaster, which make mathematics study fun and exciting, using elements of game design and allowing students to practice mathematical skills in the virtual environment. Artificial intelligence-based mathematics learning systems, such as Aleks, Smart Sparrow and Knewton, use artificial intelligence to personalize the learning process for each student based on its progress and success, as well as provide individual comments and instructions to help them improve their mathematical skills.

But despite the variety of educational technologies, the practical implementation of these courses around the world showed that their use requires a clear system of didactic development of the discipline, structuring the curriculum, developing a scheme of interaction between the teacher and the student, the availability of information and software support.

The subject, which is taught remotely, has certain didactic features. It is a clear structure that includes a methodological section, a meaningful section, diagnostic-correction blocks.

The methodological block aims to give detailed instructions, to teach the student to work properly with a large flow of information received at a distance (to collect facts, to analyze, to hypothesize, to make generalizations, to find alternative solutions, to establish patterns, to draw conclusions).

The content block is the didactic equivalent of the relevant science. We define the principles of content selection in the conditions of distance learning: the focus of content on future professional activity; ensuring the differentiation of educational tasks; choice of ways to manage students' educational and cognitive activity; interactivity; ensuring the clarity and sufficiency of educational material; feedback; modularity and structure, dynamism and multivariate access to educational material.

But, the peculiarity of distance education is, first and foremost, forms of study. Recently, the material in the form of video lectures (webinars) has become popular. Webinar (Webinar-Web-Based Seminar), is translated as a "seminar organized on the basis of web technologies". Webinar is interactive technology. The webinar listeners not only listen and "see" the teacher and demonstration materials, but can also ask him questions orally or in writing directly in the chat. The speaker also "sees" all participants and can address the question of everyone at once or to individual. Webinars (depending on the provider) may have anonymity function. The remote form of presentation of the material has a number of special requirements. The practice of conducting this kind of classes allowed us to produce the main ones:

– presentation materials should be informative, but not supersaturated. The font should not be excessively small, the colors of execution should be high contrast;

– it is not recommended to change frames;

– if students need to explain the complex formula or material for understanding which it is necessary to focus and be as careful as possible, then there is no point in including multimedia elements in this slide;

– the attention of the listeners when submitting information in this format is easily scattered. Therefore, it is necessary to change the tone of the lecture, ask questions, change the type of information;

– the lecturer should actively comment on the presentation material.

In turn, the competent use of multimedia technologies in the educational process, of course, leads to a faster understanding and new information assimilation.

Outside of the lecture, as a rule, the bulk of the content of the discipline is transmitted by an electronic guide that contains theoretical information equipped with hyperlinks and vivid multimedia illustrations (graphics, audio and video), educational interactive models, practical tasks, computer laboratory work, on-line A laboratory, a training-test unit integrated with the task base, focused not only on work on a local computer but also on local networks and on the Internet and more.

In addition, remote forms of learning provide for the ability to solve tasks, perform control tests, communicate with a virtual teacher, receive advice on the Internet or, as mentioned above, directly communicate with the virtual audience on-line in the chat during the webinar.

The diagnostic-correction unit is characterized by the presence of mechanisms for diagnosing the quality of students' knowledge with their subsequent correction. In this component of control over students' learning activities (in the conditions of distance learning) is supplemented by the study of input and output parameters. This block provides rigid and regular reporting, which makes it impossible to assist. The criteria of this component are selfassessment of one's own abilities, the ability to improve self-improvement, taking into account individual characteristics. The mentality of Ukrainian students and the normative unresolved issue of organization and of knowledge assessment does not allow to distance this block completely.

Therefore, the teacher can use distance courses or their components for:

– demonstrations and illustrations of texts, formulas, unobstructed phenomena;

– solving experimental problems using animated experiments;

– carrying out practical and laboratory work;

– control over the level of students' knowledge by differentiated learning methods;

– current knowledge control using modern technologies distance learning;

– independent creation of a computer experiment.

The main tasks of developing teachers' qualification to distance learning include: adaptation of computer technologies of distance learning; selection of optimal theoretical material; choosing the most effective forms, methods and techniques of learning, which create the necessary conditions for self-processing of information; Separation and introduction into the educational process of pedagogical conditions that contribute to the qualitative learning of knowledge.

Summing up, we conclude that pedagogically justified introduction of distance learning has a number of advantages:

– significant savings of time, money. The learning process will not interfere with the factors of time and geographical location;

– high degree of interactivity. Listeners are actively involved in the learning process, they can ask questions, finding out, incomprehensible moments;

– methodical materials are constantly accessible, webinars in the record. This allows students to develop an individual mode of training;

– increased clarity and intensity of learning;

– instant updating of the discipline content;

– replenishing the content of unobserved processes and phenomena that require figurative perception;

– along with demonstration and laboratory devices and tools, the use of high quality demonstration models created on the basis of information and communication technologies of training;

– release from routine calculations and repetitive algorithms;

– availability of training for people with physical disabilities that make it impossible to gettend.

However, now there are a number of drawbacks:

– psychological unwillingness and insufficient computer literacy of individual students and teachers;

– lack of conscious motivation, self-discipline, need for self-education of some students;

– weakening or lack of psycho-emotional contact of the teacher with the audience;

– need for quality technical equipment;

– lack of constant control.

In crisis, there is a desire for young people to combine work and learning. In order to train skilled personnel for the agrarian sector of the Ukrainian economy, the convergence of theory and practice, education and production is an urgent problem of deepening integration ties in the system "Science-Education-Production". The Ministry of Education and Science of Ukraine launches the first pilot projects, within the framework of new organizational and removal forms of education. For the testing of dual education, including agricultural professions.

However, in the context of the consortium, the forms of specialists training change, acquiring the trait of dual education, which primarily involves the combination of classrooms and the ability to gain practical experience in production.

The implementation of the idea of dual education also requires each student to provide a personal educational tractor, which is formed on the basis of individual qualities and abilities of a specialist.

In these circumstances, there are contradictions: between traditional and innovative forms of learning, which are aimed at meeting the personal and professional needs of students.

One of the promising forms of interaction of educational institution and industrial training, with the purpose of optimal realization of the potential of the future specialist, is remote interactive, which allows to actively receive educational services without detachment from production.

In addition, the model of interconnections of structural units of the consortium allows the use of a variety of interactive forms to cooperate theorists and practitioners: conferences, seminars, round tables, forums, scientific student circles, practical training of students on the basis. It is important that in addition to active forms of communication, with appropriate technical equipment, direct interaction can occur remotely. Since students are able to consult a variety of sources, both from scientists and practitioners, to test theoretical developments in practice, to share their own experience.

The rapid development of information technology gives new opportunities in the process of education, but also requires systematic use.

In particular, new forms, taking into account the interactivity and remoteness of preparation, provide transformation of courses of all training cycles and have a number of special stages:

1. Determining the goals of preparation taking into account the peculiarities of the specialty in which students study.

2. Correction of curricula and programs.

3. Development of forms of cooperation of personnel potential (teachers, scientists, workers in production).

4. Development of educational and methodological resources, using databases of scientific and production institutions.

5. Development of forms, methods, means of cooperation.

6. Control and correction stage.

Among the educational and methodological resources, we distinguish a webinar or a remote lecture, which is characterized by the activity of participants, openness, flexibility, accessibility, adaptability to new conditions, that is, endowed with all features of interactivity. In the context of the consortium, the main purpose of such a form of lesson is to provide theoretical material to the future to a specialist, as a basis for solving urgent needs during production practice.

In our opinion, it is advisable to first conduct lectures in the traditional technique, later – remotely, without interruption from production and the final control stage to carry out again the auditorium.

We divide the content of such lectures into three blocks: basic general education; general profile; Individual profile (taking into account the individual level of knowledge and abilities of the specialist).

We also take into account that the absence of traditional chalk and boards during distance classes involves the preparation of quality training resources: clear, informative, vivid, dynamic, which will stimulate the active interpersonal interaction of participants.

For example, having trained in the structural units of Vinnytsia National Agrarian University at the production of teachers of the Department of Mathematics, Physics and Computer Technology, they concluded that in the process of studying agronomic phenomena and processes, it is advisable to use MathCad mathematical system in many cases. This contributed to the development of teachers of mathematical preparation of future farmers in a consortium, based on the use of Mathcad mathematical system. In order to maintain interactivity, the technology, in particular, involves the use of e-mail, text messages, multimedia files.

An effective means of work coordination is the formation of a single information system and databases based on the analysis of which teachers form the content of the relevant disciplines, choosing such information technologies that best correspond to the logic of discipline and inquiries of practice.

In the context of the consortium, remote forms of learning have special didactic features:

– the possibility of virtual presence in the class of an arbitrary number of listeners;

– organization of highly specialized lectures for small groups;

– possibility of individual consultations (right of choice);

– obtaining and completing tasks at a distance;

– individual approach (the ability to record a lecture, inconsistent access to information);

– correction of the content of preparation taking into account the requests of practice (adaptation);

– use of databases of consortium institutions and enterprises;

– feedback between all participants in the preparation process (immediate response).

**6. Stages of technology of mathematical training of future farmers**

According to the theory of didactic design of information technologies of learning [33], we have developed technology of mathematical training of future farmers, based on the use of Mathcad mathematical system: the following stages:

– goal determination of studying the discipline;

– didactic principles of learning specification;

– selection and structuring the learning content, adequately given;

– choice of computer and information learning tools;

– development of levels of use of computer training;

– theoretical material development and tasks for mastering the content of the discipline;

– determination of a set of forms, methods, methods and techniques of organization of cognitive activity of students;

– control and evaluation stage;

– technology compatibility with specialists' training existing system.

According to the current state of agriculture in Ukraine, the goals of mathematical training of future agrarians are the use of mathematical apparatus, methods of mathematical modeling that would allow the future specialist to selfrealize in the performance of professional duties at a high organizational and technological level. This implies the presence of such fundamental and professionally oriented competencies that would allow to master modern equipment, technologies, ways of organizing production, adequate management decisions.

### 7. Specifying didactic principles of learning

During the development of the mentioned methodological materials, the authors adhering to the principles: scientific, systematic, accessibility, clarity of presentation of material, professional orientation of content on the basis of integration of mathematical and professional-oriented disciplines, optimality (maximum disclosure taking into account the prospects of using the system in related disciplines and professional activity). We specify some of them.

Thanks to the powerful graphic interface, the means of scientific and business graphics, the principle of clarity with the use of the Mathcad system is at the forefront in the mathematical training of specialists. The use of clarity in learning contributes to the combination of specific with abstract, rational with irrational, theoretical knowledge with practical activity.

The principle of clarity of learning is realized when the Mathcad system demonstrates the implementation of a large number of fundamental scientific achievements, knowledge of general scientific methods of cognition and methods specific to one or another stage of development of mathematics and the degree of their demand in our time are formed.

The MathCad system can be applied to one extent or another to any topic. However, its use is especially effective when the content of the lecture contains complex spatial or flat mathematical objects. This, in particular, concerns the theme "Function of the two variables", "second order surface".

In the younger courses in agrarian establishments of higher education, the scientific learning principle is closely linked to the fundamental education principle. There is an opinion of some experts that one of the aspects of fundamentalization is the strengthening of general education components. The use of Mathcad system is facilitated by interpretation formation and performance analysis, the use of databases.

The use of Mathcad in the educational process implements the principle of systematic learning, which is closely linked to the principle of science, forming the quality of knowledge that is characterized by the presence in the minds of students of structural relationships, adequate to existing, both intrasubject and crosscurricular.

For example, a number of built-in financial functions (Finance) *cnper (rate, pv, fv), cumint (rate, nper, pv, start, end, [type])*, pmt (rate, nper, pv, [[fv], [type]]), which allow to include in the process of training specialists a system of financial mathematics problems.

Modern studies show that in order to master students' knowledge in the system, it is necessary to include special methodological knowledge in the content of education, including acquaintance with the methods and stages of scientific knowledge, which is successfully implemented with the use of MathCad in teaching mathematics. As a result, students practically touch a wide range of relationships and relationships between different fragments of the structure of scientific theory. There is an important role in different levels of knowledge integration.

Without the systematicity principle, there is no maths lesson. With the Mathcad use, this principle is implemented even more broadly by reflecting meaningful and logical connections, taking into account students' cognitive capabilities, preliminary preparation and other disciplines content.

Unlike other Mathcad records, they are similarly commonly used in mathematical form, which simplifies the setting and solving of problems. *The principle of accessibility* is implemented by the possibility of the Mathcad system to be useful for students with different levels of school mathematical training. For students with a thorough mathematical base, through the use of wide calculation capabilities of the system, illustrations and animation of the studied processes, accompanied by the same or complex and voluminous mathematical calculations, the subject becomes more accessible and becomes new. For students with weak preparation, it allows you to achieve a learning goal, avoiding intermediate calculations and unfortunate errors in calculations, giving out the result in numerical, symbolic or graphic forms. The use of Mathcad allows you to calculate in seconds, which only requires the necessary data and use the appropriate built-in function.

It is important that this releases the ability to use a considerable part of the study time to solve meaningful tasks, acquire students' skills and skills of building mathematical models, interpretation and analysis of results.

We will demonstrate the implementation of *the principle of accessibility* on the example of the abstract concept of “border of function”. The use of Mathcad allows you to fulfill the following conditions: a) to follow the training from simple to complex (in the Mathcad environment it is the ability of graphic illustration, which allows to "see" the desired boundary at the point); b) from light to heavy (using a built-in function allows you to quickly find the desired result); c) from known to unknown (the ability to find the boundaries of functions allows you to use the appropriate device to solve practical problems).

*The principle of learning consciousness* is based on the postulate that knowledge cannot be conveyed. They become a person's property only as a result of independent conscious activity. Conscious learning is determined, above all, by the level of formation of motives of learning, understanding of practical value and need for knowledge for the chosen professional activity. Vivid examples of Mathcad to solve specific applied problems or modeling real phenomena are facilitated by learning. The consciousness of learning is also exacerbated by the fact that within the defined methodology it is possible to create conditions for independent cognitive activity. A significant role in this is played by the level of students of the Mathcad toolkit. Therefore, in fulfilling the requirements of this principle, it is especially important in the process of processing each topic in mathematics to apply the projection of educational material to a specific professional activity of students. After all, practice, from the point of view of the patterns of cognitive activity, is the impetus for knowledge and the criterion for testing the truth of the knowledge gained.

For example, in the process of mathematical preparation of agrarian based on the connection of mathematical concept "extremum" and economic-"optimization" we use models of optimization in economy, agronomy, based on the apparatus of differential equations, we consider models of development of population in the system "predator-victim", electrical systems [30].

Mathsad is now used in various fields of science – mathematics, physics, biology, economics, mechanics, etc. By implementing *the principle of integration of knowledge*, distinguished by us as an independent didactic principle, the use of Mathcad system in the study of mathematics in the agrarian establishments of higher education contributes to the reflection in the content of this discipline as a didactic equivalent of interior, the methodological basis of which is the process of integration and differentiation of scientific knowledge.

The system makes it possible to consider a considerable number of examples of mathematics in various fields of science and practice, that is, performs the function of its professional direction, as a manifestation of integration with professionally oriented disciplines.

Mathcad's wide capabilities make it possible to consider a considerable number of examples of mathematics in various fields of scientific knowledge, including in the agricultural sphere, the consideration of which without its use would be impossible because of the complexity of the objects under study and the limited study time.

The implementation of *the principle of professional orientation* of learning, which is of particular importance in higher education, in relation to general mathematical courses in agricultural establishments of higher education, is expressed not only by the inclusion in the educational process of individual, fragmentary knowledge studied in senior courses, but in the formation of professionally significant skills.

For agricultural specialists, it is the ability to analyze the role and degree of influence of factors and conditions on the nature of the phenomenon under study, the selection of significant and minor, the ability to identify such conditions in the dynamics of the phenomenon under study or object, when initially a secondary phenomenon becomes significant and vice versa, the ability to interpret experimentally The data presented on graphs, diagrams, histograms, tables, as well as the ability to use the Mathcad system on their own to build them.

As a result, on the one hand, the assimilation and consolidation of the necessary knowledge of this profile is ensured, and on the other – the preparation of the future specialist for successful professional activity is implemented.

The principles of measure and complexity are manifested when the use of the MathCad system is not transformed into an end in itself, but the optimal information saturation of the subject using this system, the boundless use of which can reduce the quality of assimilation of educational material, is planned and determined. After all, none of the available teaching tools can be opposed to each other, because when solving certain didactic tasks, only in certain educational situations one of them is more appropriate than the other. Therefore, it is necessary to use Mathcad in combination with others, both traditional and innovative learning.

The most significant of the additional principles that are implemented using the Mathcad system in the educational process is the humanistic principle and principle of advanced learning.

The system allows you to create the most favorable conditions for students to master the knowledge necessary for their future profession, the development of creative abilities, personal qualities. It should be remembered that future childhood experts have been involved in computer technology and have modern approaches to information. Therefore, the basic mastery of the Mathcad system is natural for them and does not require considerable effort, which contributes to the comfort and flexibility of learning.

The Mathcad system contains a powerful mathematical apparatus that contains standard mathematical functions (matrix, differential, integral calculus; numerous solution of differential equations; some statistical functions). Due to this, the principle of pre-education is realized in the ability of students to solve tasks that require those mathematical knowledge that have not yet been considered, to use the system in senior courses and in future professional activity, when only residual knowledge of mathematics is present. Students go to a higher level of mental activity – creative, which in combination with the use of information received in practice leads to the appropriate level of knowledge assimilation. Students develop knowledge-skills that allow learning information to be used in practical activity and knowledge-transformation, the means of which the previously acquired knowledge are transferred to solving new problems and problems, which characterizes the highest level of assimilation. In this case, the essence of learning lies in the active search and discovery of new knowledge by students. Therefore, the experience gained can be applied in senior courses in solving problems both within individual disciplines and interdisciplinary course or diploma projects.

## 8. Technology of mathematical training of future farmers

The content of mathematical training of future agrarians, adequate purposes, except for a certain range of competencies, declared in the normative documents of specialist training, according to this technology, first of all, provides for the possibility of selfrealization of students. Therefore, the use of Mathcad mathematical system allows you to select and structure the content of the discipline to allow the student: purposefully to achieve a subjectively significant result, to be active in the educational process on the cooperation basis, to fulfill each stage of the task, to identify personal qualities in learning, independent training, choice of own tractor, conscious and responsible preparation.

Currently, various mathematical systems are used in the educational process. They differ in the number of functions, convenience and quality of the interface with the user, graphic capabilities, applications, the ability to exchange data with other systems. Having made a comparative characteristic (37%), Mathematika (11%), Maple (20%), a number of experts, prefers Mathcad applied system.

Mathcad has a simple interface and good visualization opportunities, thanks to scientific and business graphics. Records are made in a similar mathematical form, which simplifies the setting and solving of tasks. The Mathcad system contains a powerful mathematical apparatus that contains standard mathematical functions (matrix, differential, integral calculus; numerous differential equations; some statistical functions).

The use of Mathcad in combination with modern multimedia design tools can improve the quality of material visualization and traditional presentations in various types of lectures.

We use Mathcad during mathematical preparation of future agrarians at three levels.

The first level: the traditional teaching of the mathematics course is supplemented by the teacher's use by the use of Mathcad's mathematical system on classical examples, which allows for continuity in the study of mathematical theories with the possibility of their generalization, systematization and applied orientation.

Second level: the content of the discipline is transformed through the introduction of laboratory work on which students learn to use computing and visual capabilities of the system on their own.

Third level: the range of tasks for selfperformance is expanding and an activation on the basis of a problematic approach. Students, Mathcad, solve professional tasks that involve the integration of knowledge in several disciplines and the use of a mathematical apparatus.

There are currently a large number of directories and reference sites that describe the functionality of the MathCad system with applications in various fields. At the same time, one of the problems of using mathematical systems in teaching mathematics is their lack of methodological support for specific specialties, since they are intended for a wide range of readers and not related to curricula and programs of specific specialties [32]. Therefore, these reference sources can be more complementary to the content of mathematical courses.

Development and implementation of mathematical training technology of future agrarians, based on the use of Mathcad mathematical system, involved the preparation of methodological materials in text and electronic forms, in particular, a guide, methodological guidelines, electronic manual, system of tasks for controlling knowledge that, in addition to theoretical material, contain tasks, tasks, tasks. illustrations, presentations for lecture courses, test tasks. The electronic form of methodological materials made it possible to create an information and reference hypertext structure of the course. In electronic manual it is a glossary that contains the main definitions of the course of higher mathematics. The presence of such a reference system contributed to the flexibility and optimality of training, allowed the student to see the structure of the course in a single system [29].

The peculiarity of the theoretical part of the course was its integrated content by complementing blocks that contain the basics of work in the Mathcad system and specify theoretical provisions and typical examples with illustrations (graphs, diagrams, spatial models of mathematical objects), executable in MathCad. The basics of work in the Mathcad system includes the ability of students to perform numerous mathematical calculations, use symbolic calculations to obtain analytical solution, to interpret the result. The use of the mathematical system has displaced accents from a formalized approach in the transmission of mathematical knowledge to ideological issues of modeling and solving practical tasks. Fixing and expanding theoretical provisions is carried out by selecting a system of applied content, which involves the use of the MathCAD system. The system of tasks with detailed instructions for the use of the system refers to both universal issues and takes into account the specific agrarian specialization of students. The content of methodological materials corresponds to the above three levels of system use. Therefore, in addition to typical tasks, there are examples of studying mathematical models.

Priority, adequate to our technology, you can consider problematic learning, technology of cooperation, method of projects.

The technology of mathematical training of future farmers, based on the use of MathCad involves the preservation of traditional forms of study (lecture, practical, laboratory, course, diploma project). However, significant changes are acquired by the techniques and content of their conduct, which depends primarily on the selected method of teaching using the mathematical system. In this case, they acquire new features: problem, clarity, independence, emotionality, high activity, availability of a game situation. This makes it possible to use lectures such as a problematic lecture, a lecture-conference, a lecture-consultation using illustrative reference material, a computer workshop, a laboratory training with computer modeling.

The availability of a reference system in Mathcad, multimedia distance courses and interactive lectures allowed to organize students' independent work under the guidance of a teacher at a new level.

When selecting material, we met the following requirements:

– availability of sufficient sources for processing;

– complete presentation of material in didactic educational materials;

– contain information that deepens already acquired knowledge in the classroom;

– specify the already learning theoretical provisions;

– to encourage active cognitive activity, to contain problematic issues;

– to require persistently in depth study of certain issues.

The control and evaluation stage of the described technology, involves both determining the quality of knowledge, skills and skills of students in the subject, as well as the formation of general and specific mental actions and techniques of mental activity that meet the goals of training specialists. The control system takes into account the individual psychological characteristics of students. We adhered to the principles of pedagogical control, which are usually adhered to in higher education: comprehensiveness, systematic, educational character.

Technology covers both traditional forms of control (answers to classes, speeches, independent, control works, colloquiums, tests, exams) that meet the goals of preparation and, accordingly, innovative content and forms of training and unconventional (electronic, in the form of test tasks, modeling, didactic games).

We use traditional forms of control, modeling, games in cases where the task contained professional-oriented tasks that required the independence of thinking, creativity or significant amounts of time to perform. In particular, this is a task that determines the model of a professional situation, and its research requires the use of mathematical apparatus and Mathcad.

Test control is carried out in cases where tasks contain formalized base problems that are solved by typical algorithms that did not require a considerable amount of time to perform. To exercise test control at different stages of preparation, we use the Knowledge Testing System. For this purpose a system of tasks is created, which enables the teacher to exercise all kinds of knowledge control (current, thematic, bluish, final, final). In addition, the wise, being constantly accessible anywhere, if you have an Internet, allows the user to exercise independent control at the preparation stage. Therefore, the system also contains tasks for self-testing.

The peculiarity of technology is that it fully meets the requirements of regulatory documents of training of agricultural specialists. It is compatible with the current curricula. At the same time, it is open to innovative approaches in the organization of the educational process. This technology has been tested and became part of the years tested at the Vinnytsia National Agrarian University of the Socrates Electronic System, which is a single integrated client-server learning system, which implements the functions of distance learning and management of the ZNO. It contains a single database of students (37121), Disciplines (1523), teachers and staff (1640). On this basis, the functioning of the Socrates subsystems such as a student's personal office, which, in turn, contains: an integrated distance education system, a student's training card, methodological and electronic educational materials, a system of knowledge testing “Tesaurus” [34].

Experience has shown that students were easily mastered with new technology, quickly and with pleasure mastered the theoretical provisions and techniques of solving previously complex tasks and used the skills in the future.

At the same time, in the process of transformation of the content of mathematical training, we took into account the level of intellectual skills of freshmen at the turn “School – Higher Education Institution”.

A number of issues that need to be addressed have been identified:

– vague understanding of first-year students about the future specialty;

– difficulties in mastering the curriculum related to the unsatisfactory basic level of mathematical training;

– lack of connections between abstract knowledge and their practical application;

– differences of expected ideas with real conditions of vocational training.

On the basis of the studied, we concluded that for a particular specialty it is necessary to distinguish professionally significant topics, questions, the concept of classical sections of mathematics, which have their application in professional-oriented disciplines.

In linear algebra, they are matrices and vectors of the cost of services, costs of transportation, population number, linear programming tasks. In mathematical analysis – production functions, marginal costs, labor productivity, optimization problems, volume of production, dynamics of population number. In probabilistic-statistical analysis-decision-making in conditions of uncertainty, risk, theory of choice of favorable behavior in competition, reserves of improving productivity, quality control of services.

The introduction from the first year of professional-oriented tasks, even at the level of the simplest models, allows you to implement *the principle of continuity* in learning. As the new content of mathematical disciplines becomes a reliable base for studying special disciplines, within which more complex models are considered.

For example, we consider matrix and linear models: the model of Leontiev multi-sectoral economy, aggregate sales, enterprise costs, production, equilibrium prices, production employment, technical and economic production model, model of exchange (model of international trade), production costs, proceeds.

In particular, in the process of training specialists in the field of linear algebra, we consider the model of formation and development of the ecotourism system in a particular region, since the obtained mathematical apparatus is used in the tasks of linear programming, which is the most common type of economic and mathematical modeling. In this random we use a mathematical model that looks like a system of linear inequalities proposed by Z. Semenova:

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \ldots + a_{1n}x_n \le b_1 \\ a_{21}x_1 + a_{22}x_2 + \ldots + a_{2n}x_n \le b_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ a_{m1}x_1 + a_{m2}x_2 + \ldots + a_{mn}x_n \le b_m \\ x_1, x_2 \ldots x_n \ge 0 \end{cases},$$

where $n$ – is the number of programs of different types of ecotourism ($n$ = 1,2, …);

$x_j$ – the number of ecotours conducted on the j-th program;

$a_{ij}$ – is the level of reduction of the i-th indicator ($i$=1,2,…,$m$) of the environmental state of the environment (water, air, soils, flora, fauna) as a result of one ecotour on j-th ecological tourism program;

$b_i$ – is the maximum permissible level of reduction of the corresponding indicator of the environment;

$$X – plan (x1, x2,…,x_n).$$

Assuming that the values $B(t_b)$ are known – an indicator of the health of the population at time $t_b$ (before ecotourism began) and $B(t_a)$ – an indicator of the health of the population at time $t_a$ (after how ecotourism began). Positive dynamics of ecotourism development is possible with the following restrictions:

$$B(t_b) \le r_{qk} x_i, x_i \ge 0; \; B(t_b) \le B(t_a),$$

$B(t_a) \Rightarrow \max$, where is the number of ecotours conducted under the j-th program in the time period $t$; – the number of persons with an improvement in $q$-th index ($q$=1,2,...,$s$) of those traveling under the $k$ ($k$=1,2,...,$n$) program in the time period $t$.

When implementing any amount X, the components of which satisfy the system of constraints (1)-(2), the total profit $P$ is determined by the objective function $P(X) = \sum_{k=1}^{n} c_k x_k$, where $c_k$ – is the profit from the ecotour according to the $k$-th program,

$$P(X) \Rightarrow \max.$$

Thus, the mathematical model of the development of ecological tourism in the region, the main priorities of which are the preservation of the features of the ecological state of the environment and the health of the traveling population, is determined by a system of ratios.

Next, we consider a specific situation in order to perform a quantitative analysis. Let's assume that three ecotourism programs listed in Table 1 are implemented in a certain region.

According to the formulas, this model is implemented using constraints in the form of a system of linear inequalities and an objective function for which the maximum must be found.

Table 1

**The impact of various ecological tourism programs on the ecological state of the environment**

| Indicators of the ecological state of the environment | Types of ecological tourism programs | | | Maximum permissible levels of environmental load. % |
|---|---|---|---|---|
| | Active | Historical | Agrotourism | |
| Water, % | 0,9 | 0,8 | 0,8 | 20 |
| Air, % | 0,7 | 0,9 | 0,9 | 15 |
| Soils, % | 0,8 | 0,5 | 0,7 | 14 |
| Profit (UAH) | 5300 | 5000 | 3500 | |
| The number of people with improved health in a tour designed for 30 people | 25 | 10 | 28 | |

Usually, problems of this type are solved by the simplex method, which is quite cumbersome. In the process of mathematical training of specialists, we used the universal integrated Mathcad system, which allows you to easily and visually enter initial data, carry out a traditional mathematical description of solutions, and receive calculation results, both analytically and numerically, with the use of graphic interpretation if necessary. This made it possible to consider both the simplest mathematical models and to use complex mathematical apparatus, to delve deeper into the essence of the process, without being distracted by cumbersome calculations, to develop universal models and algorithms.

The implementation of the mentioned model in Mathcad allows you to use the builtin Maximize function and immediately obtain the values of the variables at which the functions acquire the maximum value under the given restrictions.

The optimal value of the profit function $P(x) = 1{,}028 \times 10^5$ is reached at the point with coordinates: $x_1 = 13{,}784; x_2 = 5{,}946; x_3 = 0.$

The optimal value of the population health indicator $B(x) = 549{,}451$ is reached at a point with coordinates: $x_1 = 9{,}13; x_2 = 0; x_3 = 9{,}565.$

Many models are based on the apparatus of limit analysis, differential and integral calculus. These are models of continuous interest accrual, labor productivity, marginal costs, marginal income, elasticity, utility, determination of maximum profit, optimal allocation of resources, optimization of enterprise taxation, the problem of price discrimination, determination of profit from the production of several types of goods, model of production volume, production costs, enterprise income, capital formation, discounting, consumer surplus (profit), distribution of population income.

It is worth noting that optimization problems, which require the use of the differential calculus of functions of one and several variables, occupy a significant place in mathematical modeling. As mentioned earlier, we begin by considering the simplest models, which require the study of a function of one variable per extremum. What volume of products should be produced to ensure the highest profitability of enterprises? How to organize transportation, minimizing costs?

Next, we consider models of optimization of functioning, development and placement of economic systems, optimal management, optimization of loads, which allow us to find the best organizational, technological and spatial structure, taking into account inter-branch connections.

This often requires investigating a function of two and many variables. The presence of built-in functions for finding extrema in Mathcad allows you to visually, quickly and effectively solve this problem.

Due to this approach, the problem of knowledge consolidation is solved, which allows to consider a larger number of models in the freed time.

The presence of a built-in function in Mathcad for finding integrals of analytically given expressions and constructing graphs of functions allows you to implement models that require an integral calculus apparatus. An interesting example is the assessment of the degree of uneven distribution of the population's income. In this case, we use an integrative approach at the level of synthesis of economic and mathematical concepts. We consider the Lorenz curve as a function of one variable $y = f(x)$, where $y$ – is the share of total income $x$ received by the population. Next, we introduce the concept of the Gini coefficient – an indicator of inequality in income distribution, which is equal to the ratio of the area of the figure formed between the Lorenz curve and the line of absolute equality to the area of the triangle formed by the line of absolute equality and the coordinate axes.

By studying the Lorenz curve – the dependence of the percentage of income on the percentage of the population that has them, we can estimate the degree of inequality in the distribution of income of the population. A sufficiently high value of the Gini coefficient shows a significantly uneven distribution of income among the population in a given country.

For example, according to a study of income distribution in one of the countries, the Lorenz curve is described by the equation $y(x)=1-\sqrt{1-x^2}$ , where $x$ – is the share of the population, $y(x)$ – is the share of the income of the population. Calculate the Gini coefficient [10, p. 70].

Solution. Ginney coefficient is calculated as the difference of the area: $K=S_{OAB}=S_{OCB}-S_{OABC}=1-2(1-S_{OABC})$ ,where $S_{OAB}$ – is the area of the triangle with side 1. The area of the OABC curvilinear trapezoid is found using the specified integral:

$$S_{OBAC}=\int_0^1\left(1-\sqrt{1-x^2}\right)dx=\int_0^1 dx-\int_0^1\sqrt{1-x^2}\,dx=1-\int_0^1\sqrt{1-x^2}\,dx\,.$$

$$\text{So }\; K=1-2\left(1-\int_0^1\sqrt{1-x^2}\,dx\right)=2\int_0^1\sqrt{1-x^2}\,dx-1\,.$$

Using replacement, for example, $x=\sin t$ can be calculated $\int_0^1\sqrt{1-x^2}\,dx=\frac{\pi}{4}$. So, Ginney's coefficient $K=2\cdot\frac{\pi}{4}-1=\frac{\pi}{2}-1\approx 0,57$.

The versatility of the created model allows you to calculate the Ginny coefficient in other countries or at other times, substituting only a new Lorenz curve $y=f(x)$.

In this approach, it is important that in the process of integration in Mathcad does not have a significant value of the type of under integral function and the level of complexity of finding the corresponding integral. This allows you to expand the circle of the models being considered. In addition, the use of Mathcad allows you to vividly and at the same time illustrate the behavior of the appropriate function.

In economic dynamics models, differential equations are widely used in which there is not only a connection between variables relative to time, but also their interconnection. The study of differential equations we begin with the simplest models of macroeconomic dynamics.

Example. The agricultural firm sells its products with weekly breaks, with the initial price 15 UAH per kilogram. Determine the conditions of equilibrium on the market if the demand Q and supply S is given by the following functions: $Q = 4p' - 2p + 39$; $S = 44p' + 2p - 1$; where $p$ – the price of products; $p'$ – instant speed of price change (price change trend).

Solution: from the condition of equilibrium on the market ($Q = S$) we make a differential equation: $4p' - 2p + 39 = 44p' + 2p - 1$. Having solved it relatively $p'$, we have: $p' = \frac{10 - p}{10}$. Since $p'$ – instant speed, the speed of price change in time t can be given as the ratio of differentials: $p' = \frac{dp}{dt}$, where $p = p(t)$. Then we have a differential equation with separated variables: $\frac{dp}{dt} = \frac{10 - p}{10}$. When you get, $\int \frac{dp}{10 - p} = \int \frac{dt}{10}$ we get $\ln|p - 10| = -\frac{1}{10}t + C$; $p = e^C \cdot e^{-\frac{t}{10}} + 10 = C_1 \cdot e^{-\frac{t}{10}} + 10$ – general solution of differential equation (Figure 1).

From the initial conditions $p(0) = 15$ we find sustainable $C_1 = 5$. Therefore, the partial solution of the equation $p(t) == 5 \cdot e^{-\frac{t}{10}} + 10$ expresses the dependence of the price on time. Under equilibrium, the fall in price will not affect the volume of demand. It will match the proposal. The Solve and Odesolve built-in Mathcad allows you to solve the equation relative to and obtain graphs of the derivative function of the price $p$ and the solution of the differential equation.

However, to follow the course of solving the differential equation of MathCad also allows (Figure 1). In this case, we use integration tools, solving equations and a function graph.

In addition, a mathematical model in Mathcad makes it possible to study the dependence of solution on the initial conditions. That is, to analyze the impact of the initial price on the nature of its change in the future.

As the mathematical apparatus expands, we further consider the models of natural growth of production, growth in competition, Evans model, dynamic Keynes model, neoclassical model of growth, market with projected prices, changes in enterprise funds.

In the context of the problem of realization of professional and competency model of mathematical training of students, scientists argue that the successful implementation of the relevant model is closely related to the

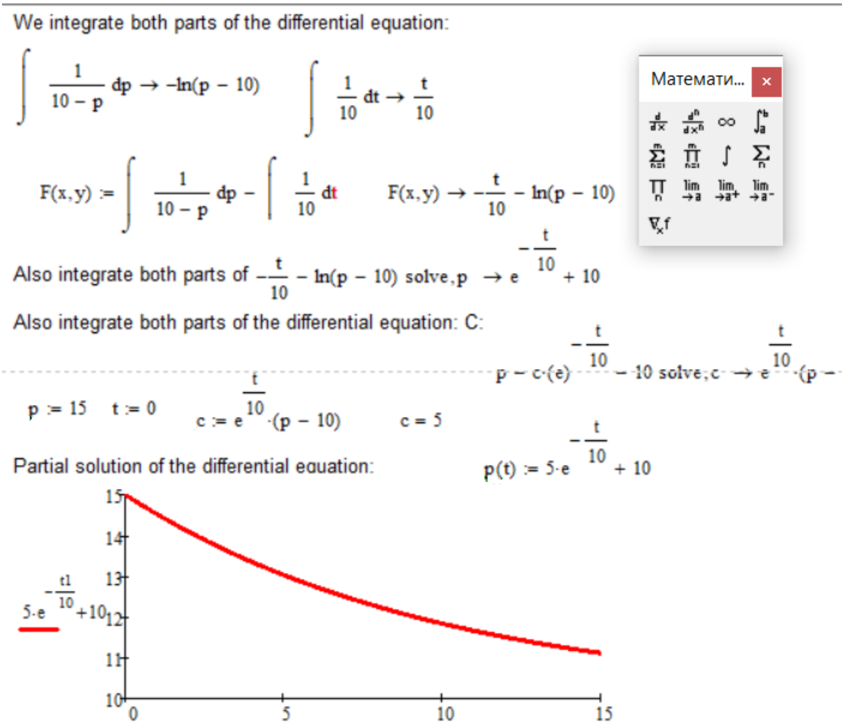


**Figure 1. Mathcad Working Document**
**"Solving Differential Equations by Integration"**

possibility of establishing integration relations with analytical departments of regional corporations, firms, etc. Business test.

Turning to the problem of transformation of the content of mathematical education taking into account the professional orientation of higher education institutions, scientists note that it is necessary to transfer the accents to mastering specific methods and techniques to master the general ways of analysis, design and implementation of pedagogical activity for the development of research.

A research approach using information and communication technologies is also considered as the basis of a methodological system of acquisition of mathematical competences in mathematical education.

At the same time, distance learning has a negative impact on students' communication. The solution of common research problems helps to improve communication in the circle of like-minded people, the realization of leadership abilities and adequate self-esteem.

In the context of the problem of psychology of creative mathematical thinking, it is believed that traditional approaches to improve mathematical education.

They are consistent, arranged on the basis of research approaches in learning. After all, the psychological content of creative mathematical thinking lies in the simultaneous through the passage of three components: the process of understanding, the process of forecasting of solution, the process of testing mathematical results.

In the dissertation of N. Glovin is substantiated and pedagogical conditions of formation of research skills of students of agrotechnical institutes by means of solving research problems were experimentally tested [35].

Formal analysis of the concept of "competence", formulated in terms "formation of competence" (procedural component) and "level of competence" (productive component) allows to define "mathematical competence of a specialist in a higher agricultural educational institution" as a process of formation of readiness for performing professional tasks The use of not only mathematical methods, but also personal and ideological qualities and a certain level of such readiness.

On the basis of the above, we consider the mathematical competence of a specialist in higher agricultural educational institution as a component of innovative professional competence, an element of the educational process, which is organized on the basis of mastering systematic mathematical scientific knowledge, mobilization of internal resources and worldviews.

On the basis of the studied, we came to the conclusion that in the conditions of formation of innovative competence at the stage of transition to a research type of preparation, the transformation of the mathematical component, is due to the creation of appropriate information environments, the main component of which is resources. Among them, we distinguish research tasks that have a cross-cutting nature and, unlike applied, in the conditions of use of the functional capabilities of the consortium in a small period of time, allow the theoretical layout to weave into the canvas of professional, while checking and adjusting them in practice. Thus, the inclusion of research problems in the system of preparation of future farmers is an effective means of deepening integration ties in the science-education system.

Therefore, students' ability to solve research problems in the disciplines of the mathematical cycle define mathematical competence, as an innovative one, which will allow the future agrarian on a scientific basis to creatively perform professional tasks, using not only the acquired knowledge, but also mobilizing internal resources and personal qualities.

In view of the observed, the content of training courses, including mathematical ones, should be constructed not only in descriptive plan, but also in the form of research tasks that should be solved, using all scientific and production resources of a research institution.

In order to create information environments, realizing the integrative links between theoretical and applied knowledge, we have developed a system of combining qualitative four-level research problems: Level 1 – recognition of the studied objects and methods of activity; Level 2 – application of the learned information to solve typical problems; Level 3 – application of the learned information to solve atypical problems and obtain new information; Level 4 – transformation of the learned information to solve professional problems with typical calculation and experimental tasks of an interdisciplinary nature.

Making methods of interaction of participants in the preparation process, the main thing is to associate the goals and means of achieving it, and the path to the goal should be optimal, that is, economical and effective.

Therefore, the basic principles of joint activity in solving research problems include:

1. Introduction of research tasks at the initial stage of training and their joint solution.

2. A gradual change in the forms of cooperation between the teacher and the student, according to his individual level of possession of ways of solving research problems.

3. Gradual ascent of the student to self-regulatory activity in the process of setting and solving problems.

4. In the process of solving research problems a purely professional nature, a gradual transition of a student to self-regulation of interaction in the sense of cooperation with other participants of the preparation process, attracting additional resources.

It is important that solving this type of task involves the combination of various forms of work, both individual and group, both auditory and extra-auditory, eye and remote. In the course of this type of activity, students are able to receive consultations from various sources, both from scientists and from practitioners.

At the same time, it should be understood that students of different areas of study in the agricultural institution of higher education may change in the individual trajectory of formation, as a specialist, when the first place in their educational and cognitive activity is a professional motivation, which is a major factor in the process of preparation and self-preparation.

For example, for students of economic directions, the task of forming the socio-economic picture of the world is the first place, while for students of agronomic direction it is more relevant to form a natural and scientific picture of the world.

The peculiarities of professional orientation were taken into account in the formation of information resources.

Here is an example of a research approach in the process of teaching mathematical disciplines for agrarian managers at the initial stage of study.

In this case, we relied on the fact that students, understanding the new opportunities for professional activity, which relies on a wider mathematical base, later seek to master the relevant sections on their own.

For example, if a student distinguishes the theory of differentiation of the function of one real variable, as a basic in the system of differential calculus of different functions, summarizes it in more complex cases of analysis of multidimensional processes, then he successfully combines not only knowledge The assimilation of professional-oriented disciplines, synthesizes methods of analysis of processes in professional activity.

Explaining the basic concepts of this section, we draw parallels with a professional-oriented concept of optimization, which we understand as the procedure of finding extremum (maximum or minimum) of functions that model processes in nature, economy, society, that is, the choice of the best option from many possible ones.

Since optimization is largely to find maximums and minimums of functions, we start with quite simple, but characteristic examples that can be solved using the knowledge gained at school, but for greater clarity, we give specific numerical values. Thus, we implement the didactic principles of continuity and professional orientation.

Considering that mathematical competence includes the ability to build a mathematical, in particular, a computer model, to explore it by mathematics methods using modern information and computer technologies, to interpret the results obtained, in the next stage, students, as information technologies and degrees have creativity, had the opportunity to develop an algorithm for calculations and visualization of data, thus enhancing the degree of complexity of research.

Here is one example of process automation and illustration in Mathcad. The agricultural firm produces two types of goods $G_1$ and $G_2$ sells them at a price of 1000 money. And 800 money in accordance. Volumes of production $Q_1$ and $Q_2$. The cost feature looks like: $C(Q_1;Q_2)=2Q_1^2+2Q_1Q_2+Q_2^2$ . Find the optimal values $Q_1$ and $Q_2$ (for which the profit received by the firm will be maximum). Find a profit for these values.

Demonstrated tasks are appropriate to solve the auditorium and extracurricularly, referring to various sources of information, in different forms, both individually and in micro groups. In the latter, the roles are raised independently: information collection, consultation, analytical activity, use of mathematical programs, reporting, presentation, speech-protection of work.

It is important that in senior courses as students expand professional knowledge and accumulation of experience gained in the farms of the consortium, the proposed approaches to solving problems will have their development as a solution to a purely professional problems.

## 9. Conclusions

Thus, the concept of higher mathematics course in higher agricultural institutions does not fully meet the requirements that society puts in front of a higher school today.

In crisis conditions caused by war in Ukraine, the energy deficit, there was a need to introduce remote and mixed forms of professional training of specialists, on the basis of the experience of training obtained during coronavirus infection.

We have come to the conclusion that 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 idea of the future specialist about the integrative role of mathematics in the formation of new general scientific directions, to deepen the methodological preparation and understanding of the essence of general scientific methods.

At the same time, it should be remembered that agrarian educational institutions of research type create new opportunities for integrating the training of specialists. In the context of the consortium, co-founder of Vinnytsia National Agrarian University, students have the opportunity to fundamental knowledge, theoretical developments directly to apply and test in practice in research farms.

The introduction of information and communication technologies in the educational process, first of all, involves the interaction and integrity of three components: organizational forms, didactic process and qualification of teachers.

Taking into account the noted, remote and blended learning can be spoken of as a pedagogical technology, based on the principle of independent learning and aims at creative development of personality. A prerequisite for efficient use of which is a quality information content that supports the learning process. Currently, in crisis, the educational environment of the education system of Ukraine is intended to fill the channels created by such information and to provide qualitatively new conditions for the entire education system.

Research tasks are an effective means of forming a mathematical component of innovative competence of the future agrarian. The introduction of such a component in the content of the preparation of future farmers allows to create the conditions for the formation of a holistic picture of the world, the critical thinking of a future specialist who is able to freely use information technologies in professional activity; work on research that requires quantitative analysis of objects; to carry out research activities in the agricultural sphere.

However, management of such activity will be effective if the rational organization of this type of activity is designed, the goal setting at the level of micro- and macrocells is diagnosed, a scientifically sound dosage of tasks is carried out, the formation of special and general skills is balanced, the technology of quality monitoring has been developed.

Therefore, the novelty presented with the help of Mathcad system of educational material, illustrative and practical significance of the studied concepts and concepts generates students' motivation and creates a positive emotional background. This, in turn, helps to intensify learning, which is closely related to the formation of persistent cognitive interest.

The use of Mathcad system in the process of studying mathematics in agricultural esatablishments of higher education is a method that allows you to take a fundamentally new approach in students' teaching, namely:

– it has at its basis the research nature of students' activity. It is a creative laboratory that allows students to study new objects comprehensively, to distinguish patterns and to formulate generalized statements based on their own observations, which promotes the development of creative, critical and independent thinking;

– allows students to concentrate on solving meaningful tasks, to reach the level of concepts, concepts, to consider many examples in a short time;

– forms the necessary level of knowledge of future specialists, the ability to analyze, compare, summarize, process available information, associate it with issues that are studied, thus forming a mathematical and information culture;

– teaches promptly, taking into account the fast variability of tasks, find the necessary information and effective ways of solving it;

– based on broad communication, erases boundaries and distances, attracts world mathematical and informational culture;

– promotes development and selfeducation skills.

## References:

1. Ministerstvo aghrarnoji polityky ta prodovoljstva Ukrajiny [Ministry of Agrarian Policy and Food of Ukraine]. *gov.ua.* Retrieved from: https://minagro.gov.ua/node/16015 (accessed 10 August 2022).

2. Shubravsjka O. (2012) Innovacijnyj rozvytok aghrarnogho sektora ekonomiky Ukrajiny: teoretyko-metodologhichnyj aspekt [Innovative development of the agrarian sector of the economy of Ukraine: theoretical and methodological aspect]. *Ukraine economy*, no. 1, pp. 27–35.

3. Zyukov M.E. (2013) Obuchenie vysshey matematike s ispol'zovaniem Microsoft Mathematics [Teaching advanced mathematics using Microsoft Mathematics]. *Bulletin of Taras Shevchenko Luhansk National University. Pedagogical sciences,* no. 20, pp. 67–72.

4. Katalogh osvitnikh proghram pidghotovky bakalavriv 2018–2019 n.r. [Catalog of educational programs for bachelors 2018–2019 n.y. National University of Bioresources and Nature Management of Ukraine. VOLUME 3]. *edu.ua.* Retrieved from: https://nubip.edu.ua/node/46601 (accessed 10 August 2022).

5. BaranovaV.Yu., KovalevaG.S., KoshelenkoN.G., Krasnovskiy E.A. (2007) *Osnovnye rezul'taty mezhdunarodnogo issledovaniya obrazovatel'nykh dostizheniy uchashchikhsya PISA – 2006* [The main results of the international study of educational achievements of PISA students – 2006]. Moscow: Center for Education Quality Assessment ISMO RAO. (in Russian)

6. Kornjev R.S. (2006) *Pidghotovka majbutnikh ekonomistiv-aghrarnykiv do profesijnoji informacijnoji dijaljnosti* [Training of future agrarian economists for professional information activities] (PhD Thesis), Ternopil: TNPU named after V. Hnatyuk.

7. Kaletnik Gh.M. (2013) Naukovo-navchaljno-vyrobnychyj kompleks jak koncepcija mekhanizmu perekhodu aghropromyslovogho vyrobnyctva na innovacijnu modelj rozvytku [Scientific-educational-production complex as a concept of the mechanism of transition of agro-industrial production to an innovative model of development]. *Economy of agro-industrial complex,* no. 9, pp. 5–11.

8. Kononets N. (2013) Informacijno-osvitnje seredovyshhe jak dydaktychna osnova dlja resursno-orijentovanogho navchannja studentiv u aghrarnomu koledzhi [Information and educational environment as a didactic basis for resource-oriented education of students in an agricultural college] Proceedings of the Origins of pedagogical skills: coll. of science works (Poltav. National Pedagogical University named after VG Korolenko, 2013), pp. 129–134.

9. Kyslova M.A., Slovak K.I. (2016) Metodyka vykorystannja mobiljnogho navchaljnogho seredovyshha u navchanni vyshhoji matematyky majbutnikh inzheneriv – elektromekhanikiv [The method of using a mobile educational environment in teaching higher mathematics to future electromechanical engineers]. *Information technologies and teaching aids,* vol. 1, no. 1, pp. 27–35.

10. Semenikhina O.V., Drushljak M.Gh. (2014) Komp'juterni instrumenty proghram dynamichnoji matematyky i metodychni problemy jikh vykorystannja [Computer tools of dynamic mathematics programs and methodological problems of their use]. *Information technologies and teaching aids,* vol. 4, no. 42, pp. 109–117.

11. Tryus Ju.V. (2012) Innovacijni informacijni tekhnologhiji u navchanni matematychnykh dyscyplin [Innovative information technologies in the teaching of mathematical disciplines]. *Bulletin of the National University "Lviv Polytechnic",* no. 731, pp. 76–81.

12. Gryb'juk O.O. (2014) Dejaki aspekty psykhologho-pedaghoghichnykh vymogh do komp'juterno-orijentovanykh system navchannja matematyky [Some aspects of psychological and pedagogical requirements for computer-oriented systems of teaching mathematics]. *The unity of education and scientific research is the main principle of the university.* (Ukrainian, *Kyiv., February 4-6, 2014)* (eds. *G.I. Volinka, O.V. Uvarkina, O.P. Yemelyanova).* Kyiv: Publishing house of M.P. Drahomanov NPU, pp. *5–7.*

13. Bykov V.Ju. (2016) Cyfrova ghumanistychna pedaghoghika vidkrytoji osvity [Digital humanistic pedagogy of open education]. *Theory and practice of managing social systems: philosophy, psychology, pedagogy, sociology,* no. 4, pp. 115–130.

14. Bobrycjka V.I., Procjka S.M.(2019) Orghanizacijno-pedaghoghichni umovy vykorystannja elektronnykh navchaljnykh kursiv v osvitnjomu procesi zakladiv vyshhoji osvity Ukrajiny [Organizational and pedagogical conditions for the use of electronic training courses in the educational process of higher education institutions of Ukraine]. *Bulletin of the National Aviation University. Series: Pedagogy. Psychology,* vol. 15, pp. 9–18.

15. Stoyanov A. (2018) The movement of a point set in Cartesian coordinates and studied in the MathCAD environment. Sofia, pp. 64–69.

16. Antonio A. Cuadri, José E. Martín-Alfonso, Juan Urbano 2019) Using Mathcad to facilitate the design of chemical reactors involving multiple reactions. *Computer Applications in Engineering Education*, vol. 28, pp. 293–303.

17. Pakhotina P.K. (2008) *Formuvannja informacijno-komunikacijnoji kompetentnosti majbutnikh fakhivciv z aghrarnykh specialjnostej* [Formation of information and communication competence of future specialists in agrarian specialties] (PhD Thesis), Kyiv: Institute of higher education of education of the APN of Ukraine.

18. Zhao, N., & Chen, X. (2022) Exploring the Integration of MathCAD-Assisted Mathematics Experiments into Higher Mathematics Teaching. *Computer-Aided Design & Applications,* no. 19(S1), pp. 117–127.

19. Antonio A. Cuadri,Rocío Gallego, María J. Martín-Alfonso, Clara Delgado-Sánchez, Esperanza Cortés-Triviño, Adrián Tenorio-Alfonso, Antonio M. Borrero-López, Francisco J. Ortega. A (2022) Mathcad-based educational experience to address the design of nonisothermal plug flow reactors. Computer Applications in Engineering Education, vol. 30, pp. 1145–1160.

20. Cerón-García, M. C., López-Rosales, L., Gallardo-Rodríguez, J. J., Navarro-López, E., Sánchez-Mirón, A., & García-Camacho, F. (2022) Jigsaw cooperative learning of multistage counter-current liquid-liquid extraction using Mathcad. *Education for Chemical Engineers*, vol. 38, pp. 1–13.

21. Roman, C., & García-Morales, M. (2020) On the integration of Mathcad capabilities into a mass transfer operations course in Chemical Engineering studies. *Computer Applications in Engineering Education,* vol. 28(4), pp. 938–951.

22. Novozhylova O.Gh. (2011) Pro rozvytok motyvaciji do vyvchennja matematychnykh kursiv u studentiv-ekonomistiv [On the development of motivation to study mathematics courses among economics students]. *Didactics of mathematics: problems and research coll. of science etc.,* vol. 36, pp. 43–47.

23. Rakov S.A. (2005) *Matematychna osvita: kompetentnisnyj pidkhid z vykorystannjam IKT* [Mathematical education: competence approach using ICT]. Kharkiv: X-fact. (in Ukrainian)

24. Rum'janceva K.Je. (2009) *Pidghotovka majbutnikh ekonomistiv do rozv'jazuvannja tvorchykh fakhovykh zavdanj zasobamy modeljuvannja* [Preparation of future economists to solve creative professional tasks by means of modeling] (PhD Thesis), Vinnytsia: Vinnytsia State Pedagogical University named after Mykhailo Kotsiubinsky.

25. Semenikhina O., Shyshenko I. (2013) Naslidky poshyrennja IT i zmishhennja akcentiv navchannja matematyky u vyshhij shkoli [The consequences of the

spread of IT and the shift in the emphasis of teaching mathematics in higher education]. *Higher education of Ukraine,* no. 4, pp. 71–78.

26. Kasatkin D.O. (2011) *Pidghotovka majbutnikh ekonomistiv do zastosuvannja informacijno-komunikacijnykh tekhnologhij u profesijnij dijaljnosti* [Preparation of future economists for the use of information and communication technologies in professional activities] (PhD Thesis), Yalta.

27. Kusij M.I., Chmyr, O.Ju., Karabyn O.O. (2017) Dejaki aspekty zastosuvannja prykladnykh matematychnykh paketiv Maple ta Mathcad na zanjattjakh z vyshhoji matematyky [Some aspects of the use of applied mathematics packages Maple and Mathcad in higher mathematics classes]. Proceedings of the *Informacijno-komunikacijni tekhnologhiji v suchasnij osviti: dosvid,problemy, perspektyvy (Ukraine, Lviv, October, 2017),* pp. 228–233.

28. Abramchuk, I.V., Romanjuk, O.N., & Velychko, N.P. (2017) Vykorystannja matematychnykh paketiv prykladnykh proghram dlja pidvyshhennja motyvaciji vyvchennja matematyky u VNZ [The use of mathematical packages of applied programs to increase the motivation to study mathematics in higher education institutions]. *Vymirjuvaljna ta obchysljuvaljna tekhnika v tekhnologhichnykh procesakh*, vol. 3, pp. 94–99.

29. Levchuk O.V. (2020) Vyshha matematyka [Higher mathematics]: Elektronnyj navchalnyj posibnyk. Vinnycya. *vsau.org.* Retrieved from: http://socrates.vsau.org/b04213/elbook/view_index.php (accessed 10 January 2022).

30. Levchuk O.V., Dzis V. G., Dyachy'ns'ka O. M. (2019) Pry'kladna matematy'ka na osnovi Mathcad [Applied mathematics based on Mathcad]. Vinny'cya: VNAU. (in Ukrainian)

31. Umyrkulova, Gh.Kh. (2020) Ispol'zovanie Mathcad pri obuchenii teme “Kvadratichnye funktsii” [Using Mathcad when teaching the topic “Quadratic functions”]. *Problemy pedagogiki*, vol. 51, pp. 93–95.

32. Chernyak A. (2016) Matematika dlya ekonomistov na baze Mathcad. [Mathematics for economists based on Mathcad]. St. Petersburg: BHV-Petersburg. (in Russian)

33. Kish V.V., Kanjuk O.L. (2021) Alghorytm dydaktychnogho proektuvannja informacijnykh tekhnologhij navchannja majbutnikh fakhivciv [Algorithm of didactic design of information technologies for training future specialists]. Proceedings of the Informacijna bezpeka ta komp'juterni tekhnologhiji, *(Ukraine, Kropyvnytskyi, April 15-16, 2021).* Kropyvnytskyi, pp. 73–74.

34. Elektronna systema upravlinnya “Sokrat” VNAU [Electronic control system “Socrates” VNAU]. *vsau.org*. Retrieved from: http://socrates.vsau.org/index.php/ua/pro-system (accessed 10 January 2022).

35. Hlovyn N.M. (2007) Formuvannia doslidnytskykh umin z dystsyplin pryrodnycho-matematychnoho tsyklu v studentiv ahrotekhnichnoho instytutu v protsesi fakhovoi pidhotovky [Formation of research skills in the disciplines of the natural and mathematical cycle in students of the agricultural technical institute in the process of professional training] (PhD Thesis), Ternopil: TNPU named after V. Hnatyuk.