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THE ROLE AND PLACE OF MATHEMATICAL MODELS IN TEACHING STUDENTS TO SOLVE OPTIMIZATION PROBLEMS

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Abstract

The article reveals the role and place of mathematical models usage in training of economic specialties students in the solving the optimization problem with the purpose of development their level of economic thinking. The main goals of teaching mathematics include the formation of skills to build mathematical models of the simplest real phenomena, to investigate phenomena according to given models, to construct applications of models. One of the means of realizing this goal is the method of mathematical modeling. Mathematical modeling, in the narrow sense of the word, means a description in the form of equations and inequalities of real physical, chemical, technological, biological, economic and other processes. In order to use mathematical methods for analysis and synthesis of various processes, it is necessary to be able to describe these processes in the language of mathematics, that is, to describe them in the form of a system of equations and inequalities. When constructing a model, such thinking operations are used as analysis through synthesis, comparison, classification, generalization, which contribute to its development. Compiling a mathematical model, translating the task into the language of mathematics prepares students for modeling real processes and phenomena in their future professional activities. Mathematical modeling plays a special role in the economic and scientific field of activity.

Key words: mathematical modeling, economic-mathematical model, optimization problem, economic thinking.

РОЛЬ И МЕСТО МАТЕМАТИЧЕСКИХ МОДЕЛЕЙ В ОБУЧЕНИИ СТУДЕНТОВ РЕШЕНИЮ ЗАДАЧ ОПТИМИЗАЦИИ

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Аннотация

В данной статье раскрывается роль и место использования математических моделей в обучении студентов экономических специальностей решению задач оптимизации с целью развития их уровня экономического мышления. К основным целям обучения математике относится формирование умений строить математические модели простейших реальных явлений, исследовать явления по заданным моделям, конструировать приложения моделей. Одним из средств реализации этой цели является метод математического моделирования. Под математическим моделированием, в узком смысле слова, понимают описание в виде уравнений и неравенств реальных физических, химических, технологических, биологических, экономических и других процессов. Для того чтобы использовать математические методы для анализа и синтеза различных процессов, необходимо уметь описать эти процессы на языке математики, то есть описать в виде системы уравнений и неравенств. При построении модели используются такие операции мышления, как анализ через синтез, сравнение, классификация, обобщение, которые способствуют его развитию. Составление математической модели, перевод задачи на язык математики готовит студентов к моделированию реальных процессов и явлений в их будущей профессиональной деятельности. Особую роль математическое моделирование играет в экономической и научной сфере деятельности.

Ключевые слова: математическое моделирование, экономико-математическая модель, задача оптимизации, экономическое мышление.

ОПТИМИЗАЦИЯНЫҢ МӘСЕЛЕЛЕРДІ ШЕШУ ҮШІН СТУДЕНТТЕРДІ ОҚЫТУДЫҢ МАТЕМАТИКАЛЫҚ МОДЕЛЬДЕРІНІҢ РӨЛІ ЖӘНЕ ОРНЫ

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Аңдатпа

Бұл мақалада экономикалық мамандықтардың студенттерін экономикалық ойлау деңгейлерін дамыту мақсатында оңтайландыру мәселелерін қалай шешуге болатындығын оқытуда математикалық модельдерді қолданудың рөлі мен орны ашылады. Математиканы оқытудың негізгі мақсаттарына қарапайым нақты құбылыстардың математикалық модельдерін құру, берілген модельдерге сәйкес құбылыстарды зерттеу, модельдердің қосымшаларын құру дағдыларын қалыптастыру кіреді. Бұл мақсатты іске асырудың бір құралы - математикалық модельдеу әдісі. Математикалық модельдеу сөздің тар мағынасында нақты физикалық, химиялық, технологиялық, биологиялық, экономикалық және басқа процестердің теңдеулері мен теңсіздіктері түрінде сипаттаманы білдіреді. Әр түрлі процестерді талдау және синтездеу үшін математикалық әдістерді қолдану үшін бұл процестерді математика тілінде суреттей білу керек, яғни оларды теңдеулер мен теңсіздіктер жүйесі түрінде сипаттау қажет. Модель құру кезінде мұндай ойлау әрекеттері оның дамуына ықпал ететін синтез, салыстыру, жіктеу, жалпылау арқылы талдау ретінде қолданылады. Математикалық модель құрастыру, тапсырманы математика тіліне аудару студенттерді болашақ кәсіби қызметінде нақты процестер мен құбылыстарды модельдеуге дайындайды. Математикалық модельдеу қызметтің экономикалық және ғылыми саласында ерекше рөл атқарады.

Түйінді сөздер: математикалық модельдеу, экономикалық-математикалық моделі, оптимизация мәселесі, экономикалық ойлау.

Introduction

The recently changed socio-economic situation in the CIS countries entails significant changes in Outlook, culture and education. It is generally recognized that the success of each individual, the prosperity of society and the level of education are closely linked. The development of the education system is one of the factors in the progress of society.

At the current stage of development of society, the improvement of many activities is inextricably linked to formalization, one of the key aspects of which is the modeling of phenomena and objects. The application of the modeling method allows to show the universality of mathematical algorithms, makes it possible to describe the processes that are different in nature.

The use of modeling-related concepts in the process of studying mathematics allows students to form an idea of the role of mathematical methods and the nature of the reflection of mathematical phenomena of the world.

In the process of almost any activity a person must make decisions that may not always be correct. The price of error in this case directly depends on the scale of these decisions. The consequences of errors in decision - making in the sphere of Economics are usually very significant, and to prevent these errors, economic and mathematical modeling is used- a tool of a highly qualified specialist for making informed decisions and competent assessment of their consequences.

It is established that the majority of students can not and do not know how to create mathematical models of economic phenomena and processes, as often tend to just get a numerical answer to the problem. The knowledge acquired at the University, students poorly correlate with their future profession.

As a result, there are contradictions between the new requirements for vocational education in a market economy and the predominance of traditional approaches to the training of future economists, as well as between the potential of mathematical models as a means of effective vocational training and their insufficient use in the educational process.

Research methods

Descriptive, comparative methods and analysis were used in the given article.

Research results

All of the above indicates the relevance of the use of mathematical models as a means of vocational training, including students of economic specialties.

There is a need to develop methods of teaching students of economic specialties to solve applied, in particular optimization problems using mathematical models.

Thus, if in the process of teaching mathematics to students of economic direction of universities systematically apply mathematical modeling in solving optimization problems, it will provide a positive dynamics of the level of formation of knowledge and skills, as well as increase the level of their economic thinking.

The amount of information required for successful work in the specialty increases at an exponential rate. Therefore, for specialists of economic direction professionally significant qualities are the quality of the mind and especially professional thinking.

Professional thinking for economists call economic thinking [1].

Analysis of scientific and methodical literature showed that the solution of applied problems has a positive effect on the economic orientation of teaching mathematics. Therefore, the use of such tasks in the classroom makes a specific component in the development of economic thinking [2].

The study of almost any topic of the mathematical course ends with the construction of a mathematical model. Getting as a result of any formula, graph, table, diagram, students just deal with modeling.

In order for the process of teaching mathematics to have a positive impact on the level of training of highly competitive specialists, it is necessary:

– to increase the time allotted for teaching mathematics to students of economic profile;

– orient the course of mathematics on specialized training;

– to expand the teachers of mathematics economic knowledge, and teachers of disciplines of economic profile – mathematical;

– to realize the relation of mathematics to future careers.

Effective use of professional content tasks contributes to the development of economic literacy. Due to the increased complexity of economic systems, analysis of the problem conditions and drawing up a solution plan is impossible without the use of economic and mathematical methods and models. Taking a decision on the problem under consideration, guided by a formal model of the economic situation, students are able to choose the most effective and competent way of behavior.

Since we are interested in the role of models in economic research, we consider the classification of models by means of modeling – material and ideal models [3].

Material modeling is an experimental method and consists in the direct study of the model as a material object (the model of the ship, the model of the solar system).

In principle, the ideal modeling is different, which is based not on the material analogy of the object and the model, but on the conceivable.

In economic studies, this type of modeling is used, since the possibility of experimenting with material models is limited. There are two types of ideal modeling – intuitive and symbolic.

Intuitive modeling is based on an intuitive representation of the object of study, not amenable to formalization, or do not need it [4].

In sign modeling, the models are sign formations of any kind (formulas, schemes, graphs), and sign formations and their constituent elements are specified together with the laws by which they can be operated.

The considered classification can be presented in the form of Figure 1.

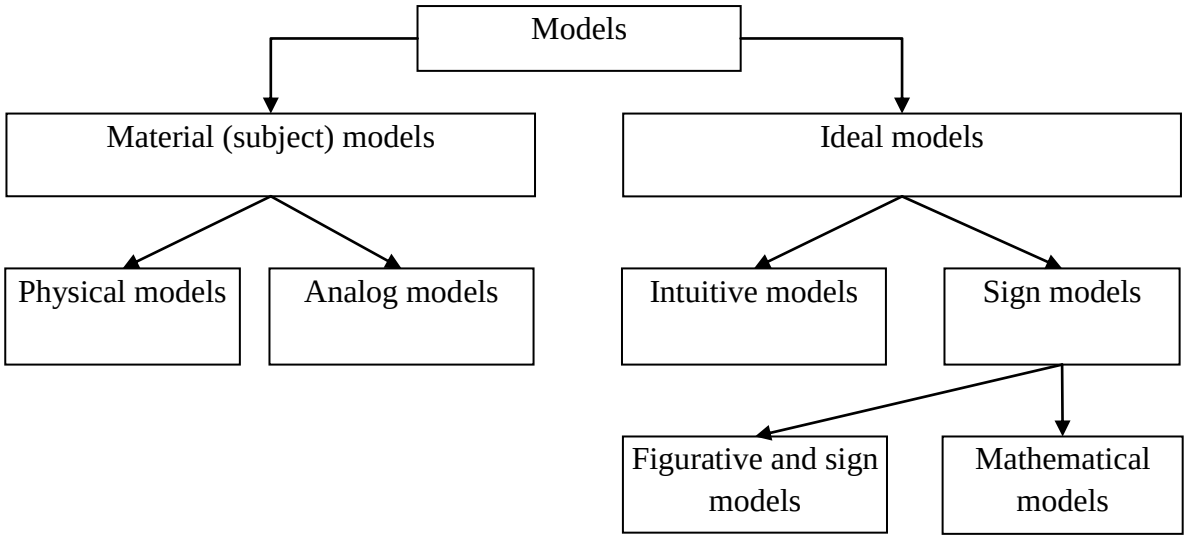

Figure 1 Classification of models by modeling tools

The most important type of sign modeling is mathematical modeling. According to most researchers, it is a reflection in mathematical form (in the form of equations, inequalities, systems, graphs, etc.) of the basic laws of the object or process being studied, used to simplify the study.

Mathematical modeling of economic processes begins its history in the XVIII century in the works of F. Kene, A. Smith, etc. During the following years, mathematical modeling of economic processes continued to develop. In the XIX-XX centuries a great contribution to the modeling of the market economy has made V. Pareto, R. Solow, W. Leontief, Leonid V. Kantorovich.

At the turn of the XX and XXI centuries, continuing to develop, mathematical methods of modeling of economic processes are moving into new qualities: economic-mathematical and simulation.

In modern literature, economic-mathematical modeling is understood to mean the construction of an economic-mathematical model (EMM), putting under it a mathematical description of the economic process carried out for the purpose of research or management.

Economic-mathematical models can be divided into a number of classes [5]:

–macroeconomic (characterize the economy as a whole, connects aggregated material and financial indicators) and microeconomic (describe the interaction of structural components of the economy);

–theoretical (study the general properties of the economy by deduction of conclusions from formal assumptions) and applied (describe specific economic processes to obtain practical recommendations);

–balance sheet (ensure the achievement of economic equilibrium) and optimization (contribute to the selection of the best behavior for maximum profit or minimum costs with given resource constraints);

–static (describe the state of the economic process at a particular moment in time) and dynamic (explore economic processes in time);

–deterministic (suggest the presence of rigid connections between model elements) and stochastic (allow the influence of random factors on the economic process under study).

An optimization model is an economic-mathematical model that encompasses a number of production, distribution, or consumption options and is designed to select the values of the variables characterizing these options so that the best one is found.

The results of the analysis of the types of various optimization problems in the economic sphere, depending on the economic and mathematical model used in their solution, are presented in Table 1.

Table 1 The choice of economic-mathematical model to solve the optimization problem

The economic meaning of the task	Used EMM
The choice of the optimal solution to the economic problem, in which the conditions are described by equations, inequalities of the first degree	Linear (integer linear) programming model
The choice of the optimal solution to the economic problem, in which the conditions are described by equations, inequalities of degree higher than the first	Nonlinear programming Model
Choosing the optimal plan for a multi-stage economic situation in which the results of each subsequent stage depend on the previous	Dynamic programming model
Development of economic decisions in an uncertain situation caused by hostile actions of the conflicting side	Game theory model
Preparation and implementation of rational plans for economic operations that provide for solving the problem as soon as possible	Network planning Model

Modeling as a whole includes a number of stages based on a systematic approach [5]:

– formulation of the subject and purpose of the study;

– identification of structural elements relevant to this goal, and their most important characteristics;

– verbal, qualitative description of the relationships between model elements;

– introduction of symbolic notation and formalization of relationships (direct construction of a mathematical model);

– mathematical model calculations;

– analysis and interpretation of the solution.

Thus, after passing through these stages, the requirements for the models can be most fully satisfied:

– universality - the completeness of the model displaying the studied properties of the original;

– adequacy - the ability to reflect the necessary properties of the original with an error not higher than permissible;

– accuracy - the degree of coincidence of the characteristics of the original with the values obtained using the models of characteristics;

– profitability - the cost of resources and time for the implementation and operation.

– The mathematical approach to modeling can have several disadvantages:

– low adequacy of the mathematical model to the original;

– the presence of discontinuous functions in mathematical models, which affects their solvability;

– unsuitability of mathematical models for many objects with variable structure.

However, with the correct execution of all six stages of modeling, economic-mathematical models can and should serve as a very powerful tool for the optimal adoption of many managerial decisions in the economic sphere:

–type and volume of goods planned for purchase, production or shipment;

–product range and specific markets for its promotion;

–groups of suppliers and buyers for closer cooperation;

–place, time and method of conducting advertising campaigns;

–direction for the work of the marketing department, etc.

–But in the process of modeling a particular economic process, it is important to consider the following aspects of the application of specific economic and mathematical models:

–completeness and reliability of the data used;

–correct statement of the problem;

–the correct choice of calculation method.

Conclusion

You can highlight the basic principles of creating a mathematical model for the optimization problem:

– when describing the model, it is necessary to identify as many parameters as possible influencing the desired result;

– the algorithm of the developed model should be as simple as possible; the model should be built in such a way that it can be evaluated, verified (including by “manual” recounting) and understood;

– the resulting results should be interpreted equally by the creators of the model and its direct users.

The solution of applied optimization problems using mathematical models provides the following functions:

– obtaining information about the studied object;

– the ability to create a generalized model of the original based on the study of its individual properties;

– allows you to judge real objects based on analysis carried out on models;

– allows you to connect the study of objects with analogues in other areas more convenient for observation.

In the process of solving optimization problems with economic content, using mathematical models, students operate with professional terms, acquire the ability to analyze situations typical for future professional activities in the field of economics.

As a methodological basis for constructing a methodology for teaching students to solve applied optimization problems, the consecutive implementation of the idea of modeling is accepted with the necessary attention to all six stages of activity.

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