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TÍTULO: Acerca del problema de enseñar a estudiantes de universidades médicas a resolver problemas de biofísica.

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RESUMEN: El estudio aborda el problema de enseñar a los estudiantes de las universidades médicas a resolver problemas de biofísica, en particular a formar los métodos para resolver problemas de biofísica entre los futuros médicos. Se presta especial atención a la necesidad de un trabajo especialmente organizado para la asimilación de actividades dirigidas al desarrollo de modelos matemáticos de problemas y su resolución con el uso de aparatos matemáticos avanzados. En este sentido, los tipos de problemas se establecieron de acuerdo con los métodos aplicados de análisis matemático y se identificaron sistemas de acción generalizados para desarrollar el modelo matemático de estos tipos.

PALABRAS CLAVES: metodología para enseñar la biofísica, aplicación de las matemáticas superiores, solución de problemas de biofísica.

TITLE: On the problem of teaching students of medical universities to solve problems on biophysics.

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ABSTRACT: The study addresses the problem of teaching students of medical universities to solve problems on biophysics, particularly forming the methods of solving problems on biophysics among the future doctors. Special attention is focused on the need of specially organized work on the assimilation of activities directed at developing mathematical model of problems and their solving with the usage of advanced mathematics apparatus. In this regard, types of problems were established according to the applied methods of mathematical analysis and generalized systems of actions for developing the mathematical model of these types were identified.

KEY WORDS: method of teaching biophysics, application of advanced mathematics, solving problems on biophysics.

INTRODUCTION.

It is an indisputable fact that the current stage of science and technology development contributes to protecting and promoting people's health. Application of high-tech equipment allows implementing a high-level treatment, diagnostics and prevention of different diseases. Moreover, methods of study the reasons of various illnesses, their diagnostics and treatment methods on a molecular level tend to increase. Thus, the future doctor as a today's medical university student should have knowledge not only in the field of special disciplines, but also in mathematics, physics and biophysics.

Traditional element of professional training of medical university students is studying the basis of biological (medical) physics. Unfortunately, the analysis of scientific research literature reveals that nowadays there is a sparse number of studies disclosing the methods of teaching biophysics to the future doctors.

There is a number of textbooks [1,2], author's lecture courses [3,4], exercise manuals [5] as well as laboratory courses [6,7]on biophysics, but there are only two studies in the field of theory and methods of teaching biophysics to the future doctors [8,9]; for example, A. Egorenkov's study deals with solving the problem of teaching molecular biophysics to medical university students. The author developed a method of teaching students on the basis of systematic approach including structuring the course of molecular biophysics, practical lab sessions on physical aspects of genetic code and means of test control. The given study focuses its attention on the methods of holding practical classes on DNA biophysics with different complexity level considering the students' beginner knowledge level [8, p.14]; for example, S. Babin studies the problem of teaching biophysics to future doctors, particularly the methods of studying conservation law in the course of medical and biological physics [9]. By emphasizing the significance of conservation laws for the study of a human organism as an open thermodynamic system, the author develops the teaching method directed at learning the applications of conservation laws forming skills of solving problems on biophysics.

To summarize, it may be established that there is an under-development of issues connected with theory and methods of teaching biophysics to future doctors in scientific research literature. The problems of biophysics syllabus in medical universities under the following conditions remain unsolved: decreased class hours, methodological approach of first-year students with a low knowledge of mathematics and physics, developing special didactic and control means, forming the competence of future doctors while studying biophysics, implementing Federal Educational Standard of higher education, etc.

DEVELOPMENT.

The range of unsolved issues is rather wide. In our study we paid attention to the problem of teaching medical university students to solve problems in biophysics course. The timelessness of the given

issue is conditioned by the results of the ascertaining experiment held in the framework of our study. We noted that the majority of the first-year students (89,5%) have difficulties while solving problems on biophysics. The difficulties were connected to the application of advanced mathematics apparatus. For dealing with the given issue, it is necessary to develop effective ways of teaching the students of medical universities to solve problems on biophysics. Analysis of academic literature revealed that one of the most effective ways is the approach of solving problems based on the activity theory [10,11].

Including elements of activity theory as the theoretical basis of the study allows forming generalized methods of biophysical problem solving among the students. I will allow implementing these methods for solving the wide range of problems including problems in physics, medical statistics and public health principles.

The given approach was implemented for the first time by G. Stefanova for developing the methods of forming the generalized methods of solving problems on physics among senior pupils [12]. One of the actions of the given method is compiling the mathematical model of the situation described in the problem. As noted earlier, the mathematical model of biophysics problems is mostly based on advanced mathematics apparatus. That is what causes difficulties among the students. We analyzed the most common mathematical frictions for solving biophysics problems and outlined the types of problems. The basis of solving these problems that are:

1) Fine the increment of a function y in passing from point x to point $x+\Delta x$.

2) Apply the derivative.

3) Compose and solve the differential equation of first order with separable variables.

We distinguished generalized action systems corresponding to each of the types listed above; for example, table 1 and 2 demonstrate the compilation of a mathematic model of a problem on biophysics based on composing and solving the differential equation of first order with separable

variables and applying the derivative for solving a problem on biophysics.

Table 1.

Problem. Bacteria population rate grows in such a way that the speed of its grow that the moment of time *t* is one tenth of the population size. Describe the growth process with the differential equation. What is the population size after 10 hours if the initial condition is $N(0) = 1000$? [13].	
Actions	**Action results**
1. Determine which physical quantities undergo changes in the problem situation, reveal physical laws binding them.	The problem refers to the change in the number of a closed population (N).
2. Choose the independent variable and the function of this variable that is needed to be found.	Independent variable t – time. Function $N(t)$ – population size at the time moment t.
3. Determine initial or boundary conditions according to the problem situation.	$N(0) = 1000$
4. Express all the quantities mentioned in the problem situation by means of the independent variable, the required function and its derivatives.	t – time $N(t)$ – population size $N'(t)$ – population growth rate
5. Comply a differential equation using the text of the problem or known physical conformities.	According to the problem situation, the population growth rate at the time moment t is one tenth of the population size, i.e. $N' = 0{,}1N$
6. Determine the type of a differential equation.	This is a first-order differential equation with separable variables.
7. Present the derivative y' as a ratio $\frac{dy}{dx}$.	$N' = \frac{dN}{dt}$ $\frac{dN}{dt} = 0{,}1N$
8. Separate the variables by transferring the variables containing function *y* to the left side of the equation, and the variables containing argument *x* to the right side.	Multiply both sides of the resulted equality by dt divide them by x. We get: $\frac{dN}{N} = 0{,}1dt$
9. Integrate the left side of the differential equation with respect to the function *y*, and the hand side with respect to the argument *x*.	$\int \frac{dN}{N} = \int 0{,}1dt$
10. After the integration, it is necessary to add constant of integration *C* to the right side. Get the general solution.	$\ln\lvert N\rvert = 0{,}1t + \ln C$ or $\ln\lvert N\rvert = 0{,}1t \ln e + \ln C$ $N = Ce^{0{,}1t}$ – general solution
11. If the initial conditions were established $(x_0;\ y_0)$, then constant of integration values are to be defined.	If $t = 0, N = 1000,$ then $C = 1000$. $N = 1000e^{0{,}1t}$- specific solution.
12. Get the specific solution.	After 10 hours the population size becomes equal: $N(10) = 1000e^{0{,}1\cdot 10} = 1000e = 2718.$

Table 2.

Problem. As a result of significant blood loss, the iron content in blood decreased by 210 mg. Iron deficiency decreases according to the law $y = 210e^{-\frac{t}{7}}$ mg due to its regeneration. Find out the dependence of iron regeneration rate of time. Calculate this rate at the moment $t = 0$ and in 7 days [12].	
Algorithm	**Problem solution**
1. Establish a process or phenomenon by the problem situation, reveal physical laws	The relaxation process is the process of returning the system to the state of stable equilibrium which it was thrown off from. The rate of change of some variable *y* is defined as the derivative of its time $\frac{dy}{dt}$.
2. Select the required value (function) in the text of the problem.	Function $y(t)$ – quantity of iron in blood at the time moment t.
3. Identify the independent variable.	Independent variable t – time.
4. Identify the variation function of the sought value.	$v = y'(t)$ – rate of iron regeneration in blood
5. Calculate the derivative.	$y' = (210e^{-\frac{t}{7}})'$
6. Apply differentiation rules and the derivatives table.	$y' = -\frac{1}{7}210e^{-\frac{t}{7}} = -30e^{-\frac{t}{7}}$
7. Put the initial, boundary conditions into the derivative function.	At $t = 0$ the regeneration rate is скорость 30 mg/day. In 7 days the regeneration rate is: $y'_{t=7} = -30e^{-\frac{7}{7}} = 30e^{-1} = \frac{30}{e} = \frac{30}{2,7} =$ 11,1 mg/day.

CONCLUSIONS.

For forming abilities in application, the advanced mathematics apparatus among medical universities students in particular and generalized methods of solving problems on biophysics in general, it is necessary to develop special methodology including:

1) Defining the place in biophysics course.

2) Ways of organizing special work on assimilation the established action systems.

3) Special didactic means for its implementation.

4) Methodological guidelines for the professor teaching biophysics to future doctors.

In our opinion, the selected theoretical and methodical approaches to teaching students to apply the mathematical analysis apparatus and therefore solve problems on biophysics, will increase the efficiency of teaching the basics of biophysics and will form solid foundation for the study of special disciplines.

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