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FORMATION OF PROFESSIONAL COMPETENCE OF STUDENTS OF NATURAL PROFILE FOR TEACHING INTERSUBJECT COMMUNICATIONS BASED ON INFORMATION TECHNOLOGIES

Mengliev Islam Abdumuratovich
Doctoral student of the Department of Applied Mathematics and Informatics, Termez State University,
e-mail: mengliyev1982@mail.ru

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Abstract:
This article outlines the possibilities of information technologies for the formation of professional competence of students of natural profile for teaching intersubject connections.
For this purpose, a mathematical model of diabetes mellitus described by a system of nonlinear ordinary differential equations is considered. The dynamics of changes in sugar and insulin in the human body is investigated on the basis of intersubject connections. To carry out a computational experiment, numerical methods are used that have different accuracies with respect to the grid spacing. A program was compiled in the algorithmic language C ++ and tabular and graphical results were obtained that illustrate the dynamics of changes in the level of sugar and insulin in the human body at certain values of the characteristic parameters.

Keywords: Interdisciplinary communications, professional competence, information technology, mathematical model, diabetes mellitus, sugar, insulin, algorithmic language, characteristic parameters.

The concept of interdisciplinary connections in pedagogical literature is considered from different points of view, each author tries to give his own understanding of the essence of the term, and there is still no general definition of this concept. The authors [1] note: "The variety of interdisciplinary connections in the learning process shows that the essence of a given concept cannot be determined unambiguously ... Researchers accept one point of view or another on the definition of the term "interdisciplinary relationships", but they do not always maintain it, and often this concept is interpreted in several meanings.
We see the reason not so much in the carelessness of using the term, but in the objectively existing multifunctional nature of the most intersubject connections".

In the scientific and pedagogical literature at the moment there are more than 40 definitions of the category of "intersubject connections", which leads to a different and not always correct understanding of the term, and therefore distorts the idea of the types, forms, types and functions of intersubject connections [2]. The first official definition of "interdisciplinary connections" appeared in 1961. In a two-volume pedagogical dictionary, where interdisciplinary connections are interpreted as "mutual coherence of curricula," endowed with a system of sciences and didactic goals [3].

Interdisciplinary connections as a didactic condition for successful learning, and this condition is interpreted differently by different authors.
For example:

- interdisciplinary connections play the role of a didactic condition for increasing the effectiveness of the educational process [4];
- interdisciplinary communication - a didactic means of increasing the efficiency of assimilation of knowledge, abilities, skills [5];

If we analyze the research of interdisciplinary connections as a pedagogical category, we can come to the conclusion that there is no single point of view on this problem, and many authors give their own concept.
For example:

- interdisciplinary connections - an integrated approach to upbringing and teaching, allowing to isolate both the main elements of the content of education, and the relationship between academic subjects [6];
- intersubject connections are reflections of the relationship of all the main elements of an integral system of knowledge about nature, society and man [1].

Some researchers consider interdisciplinary connections as a manifestation of the didactic principles of consistency and scientific nature.

So, the author of the book [1] believes that the principle of consistency is the main didactic principle, and interdisciplinary connections are one of the sides of this principle. "Interdisciplinary connections represent one of the specific forms of the general methodological principle of consistency," which determines a special type of mental activity - systemic thinking [1].

The author of the book [2] emphasizes that interdisciplinary connections contribute to the implementation of the scientific principle in the content of education. "Interdisciplinary connections are designed to bring to the consciousness of the student the commonality of all subjects and to show the specifics of the content and methods of science in each academic subject" [2].

The modernization of the education system in modern conditions is a rather laborious process, designed to solve the issues related in terms of the competence-based approach.

The competence-based approach presupposes the readiness and desire of a person to apply their knowledge, skills and personal qualities in a certain area of professional activity [7]. This article proposes a set of requirements grouped around three most important indicators of the quality of mastering educational programs in the preparation of bachelors and masters. These indicators include:

- a certain set of competencies, i.e. knowledge, skills and personal qualities necessary for successful professional activity;
- consistency of thinking, the formation of leadership qualities, creativity and the ability to analyze the available information;
- communication and ability to work in a team.

When these indicators are analyzed, a deep connection and interdependence between them becomes evident.

The real practice of intersubject connections is also aimed at enriching the intellectual potential of students, which is especially important in the current conditions, when the level of general cultural readiness of students is falling from year to year [7]. It is this feature of the modern generation of students that makes them look for new methods and forms of working with them, and interdisciplinary connections can be used to increase the intellectual and spiritual and moral potential of young people, their ability to work independently and sources, reference literature, analyze situations and compose texts, extrapolating knowledge gained in one field of activity to another. This, in turn, forms the culture and consistency of thinking and speech of students, contributes to the mastery of business communication skills, broadening the horizons of young people.

The purpose of this article is to disclose the content of the concept "interdisciplinary connections in the formation of professional competence of students of biological and medical profile on the basis of information technology and mathematical modeling."

At the modern stage of the development of information technologies in the field of education, interest in the concept of a model and modeling methodology in relation to interdisciplinary connections is increasing. An example is the inclusion of the concepts of "model" and "modeling" in the study of intersubject connections in the subjects "Chemistry", "Biology", "Medicine", "Mathematics", "Information technology", "Programming", etc.

Information technologies play an important role in the formation of the professional competence of natural students in the teaching of intersubject communications. In this area, information technologies perform the following functions [8]:

grinds students' ideas about modeling as a method of scientific knowledge;

- promotes awareness of the modeling methodology as a whole as one of the leading in the knowledge of the surrounding world;
- provides a link between special training in the field of informatics and professional pedagogical training;
- interdisciplinary communication in relation to mathematical, natural science and highly specialized training in the field of information technology;
- deepens skills in programming and using computers.

Therefore, the use of information technologies establish a close connection between the concepts of professional competence and interdisciplinary connections, and also ensure the effectiveness, quality and improvement of the educational process.

As an example, a diagram of interdisciplinary communication for students of biological and medical faculties in the study of the disease diabetes mellitus is given (Fig.1).

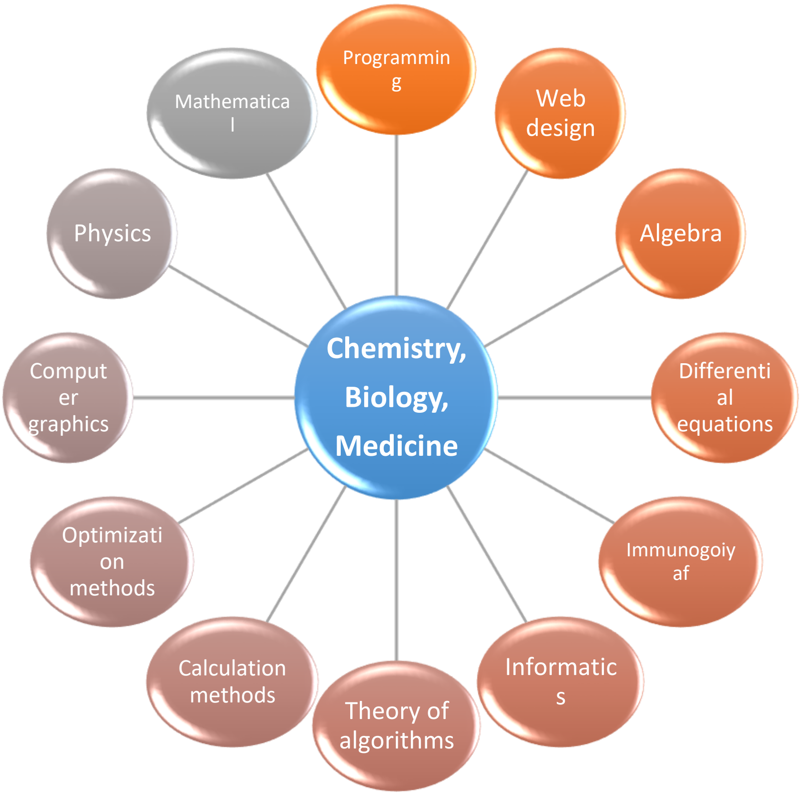

Fig. 1. Diagram of intersubject communication in the study of the disease diabetes mellitus

It is impossible to imagine modern science without the widespread use of mathematical modeling. The penetration of mathematical methods into the most diverse, sometimes unexpected spheres of human activity means the opportunity to use new, as a rule, very fruitful means of research [9-11]. In the course "Computer Modeling" the following software tools and packages are used: Mathematica, Derive, Maple, Matlab, Mathcad, etc. Mathematical systems are a convenient and powerful tool that allows you to solve correctly posed problems, have hundreds of built-in library programs and elegant capabilities for visualizing results calculations.

From a mathematical point of view, it becomes important to understand the unique capabilities of various tools for the implementation of different solutions and forms of obtaining results when solving applied problems: exact and approximate methods, symbolic, numerical and graphic methods. "Computer Modeling" provides interdisciplinary links between natural and mathematical disciplines and disciplines related to information technology.

Here is a differential model of diabetes mellitus [12]. The two main variables included in the model are quantities that can be measured or manipulated in clinical practice: blood sugar (x) and blood insulin (y). a slightly smaller role is also played by two additional variables - food input z and, for diabetics, insulin delivery w.

A qualitative description of biochemical processes in the body of a healthy person can be summarized as follows. The steady state, taken as a reference point, is the blood sugar level during fasting x_0, with zero insulin level $y_0 = 0$. If these levels differ, then they change as a result of the action of several several independent mechanisms.

The mathematical model of diabetes mellitus is described by a system of nonlinear ordinary differential equations of the form:

$$\begin{cases} \dfrac{dx}{dt} = -a_1 xy + a_2(x_0 - x)H(x_0 - x) + a_3 Q e^{-K(t-t_0)} H(t - t_0) & (1) \\ \dfrac{dy}{dt} = b_1(x - x_0)H(x - x_0) - b_2 y + b_3 Q(t_0 + t)H(\bar{t} - t) + b_3 Q(\bar{t} - t)H(t - \bar{t}) & (2) \end{cases}$$

$$t \in [t_0, T]$$

Differential equation (1) is used to model the gradient of blood sugar level. It is known that the presence of insulin leads to the metabolism of sugar, which lowers its content in the blood. The higher their blood sugar levels of insulin, the faster this drop occurs. Therefore, the first term in (1) $-a_1 xy$ at least for small changes in variables describes this effect well enough. Blood sugar levels can fall below equilibrium (for example, due to intense physical exertion during fasting). In order to raise y_0 to the normal level, carbohydrate stores are released from the liver. This effect is well reflected by the term in (1). And finally, the third term in (1) describes that the external source of blood sugar is the food consumed; it is an explicit function of time. Constants a_1, a_2 and a_3 are positive values are, respectively, the sensitivity of the gradient of the sugar level to a) the presence of insulin (a_1) b) low blood sugar (a_2) c) food intake (a_3).

To determine the level of insulin in the blood y we have the differential equation (2). The first term on the right-hand side of (2) $b_1(x-x_0)H(x-x_0)$ means that if the blood sugar level exceeds the stable level, then the pancreas of the gland secretes insulin into the bloodstream. This phenomenon can be described by a piecewise linear model. The second term in (2) $-b_2 y$ describes that the content of insulin itself decreases under the influence of several biochemical processes; in a living organism, half of free insulin is inactivated within 10 to 25 minutes. Finally, the third term in (2) means any external source of insulin. For a healthy organism, this term is identically equal to zero; for diabetics it will be a function of time t, determined by the injection schedule. Three permanent b_1, b_2 and b_3 positive by definition. They represent, respectively, the sensitivity of the insulin gradient to a) high blood sugar (b_1), б) insulin levels (b_2) and в) to insulin delivery (b_3). To mitigate the complexity of factor a), a step function was introduced $H(x-x_0)$, defined by the relations

$$H(\xi)=\begin{cases}0, \ npu \quad \xi \prec 0,\\ 1, \ npu \quad \xi \geq 0.\end{cases}$$

For numerical simulation of the system of nonlinear ordinary differential equations (1) - (2) in the interval of integration $[t_0,T]$ let's introduce a grid

$$\overline{W}_\tau=\{t_i=t_0+i*\tau,\ i=0,1,....,N,\ \tau=(T-t_0)/N\}.$$

To simplify further presentation, the right-hand sides are equalized (1)-(2) denote, respectively, by $f_1(t,x,y)$ and $f_2(t,x,y)$:

$$f_1(t,x,y)=-a_1xy+a_2(x_0-x)H(x_0-x)+a_2Qe^{-K(t-t_0)}H(t-t_0)$$
$$f_2(t,x,y)=b_1(x-x_0)H(x-x_0)-b_2y+b_3Q(t_0+t)H(\bar{t}-t)+b_3Q(\bar{t}-t)H(t-\bar{t})$$

As a result

$$\begin{cases}\dfrac{dx}{dt}=f_1(t,x,y), & (3)\\ \dfrac{dy}{dt}=f_2(t,x,y), & (4)\end{cases}$$

For the numerical simulation of the system of differential equations (3), (4), Euler's method is used, which has the first order of accuracy with respect to the grid step τ, i.e. o(τ), the first improved Euler's method having the second order of accuracy τ, i.e. o(τ^2) and the Runge-Kutta method having the fourth order of accuracy, τ, i.e. o(τ^4). Algorithms for solving the considered numerical methods are derived and a program is written in the algorithmic language C ++. The computational experiment was carried out for the following values of the characteristic parameters. The problem under consideration $x_0=0.1,\ \ y_0=0.3,\ \ a_1=0.05,\ a_2=1.0,\ a_3=0.04,\ b_1=0.5,\ b_2=2.0,\ b_3=0.2,\ \bar{t}=0.5,$ $K=1,\ Q=1$ and in grids with a step $\tau=0.01$ wherein $N=100$. The calculation results are shown in the table.

	Euler's method		Euler's first improved method		Runge-Kutta method	
i	x[i]	y[i]	x[i]	y[i]	x[i]	y[i]
0	0.100000	0.300000	0.100000	0.300000	0.100000	0.300000
10	0.176496	0.263856	0.176511	0.266185	0.176128	0.266161
20	0.245727	0.274250	0.245742	0.278044	0.245013	0.277988
30	0.308369	0.322351	0.308384	0.326986	0.307343	0.326890
40	0.365050	0.400974	0.365065	0.406005	0.363741	0.405865

50	0.416337	0.504274	0.416352	0.509393	0.414773	0.509207
60	0.462743	0.497771	0.462758	0.489393	0.460948	0.491105
70	0.504734	0.439771	0.504749	0.429393	0.502729	0.431105
80	0.542728	0.341771	0.542743	0.329393	0.540534	0.331105
90	0.577107	0.203771	0.577122	0.189393	0.574742	0.191105

From the results given in the table, it can be seen that the Runge-Kutta method provides high accuracy of calculations. These results are most clearly illustrated in Figures 2-4, where (x) is the sugar level and (y) is the level of insulin in the human body.

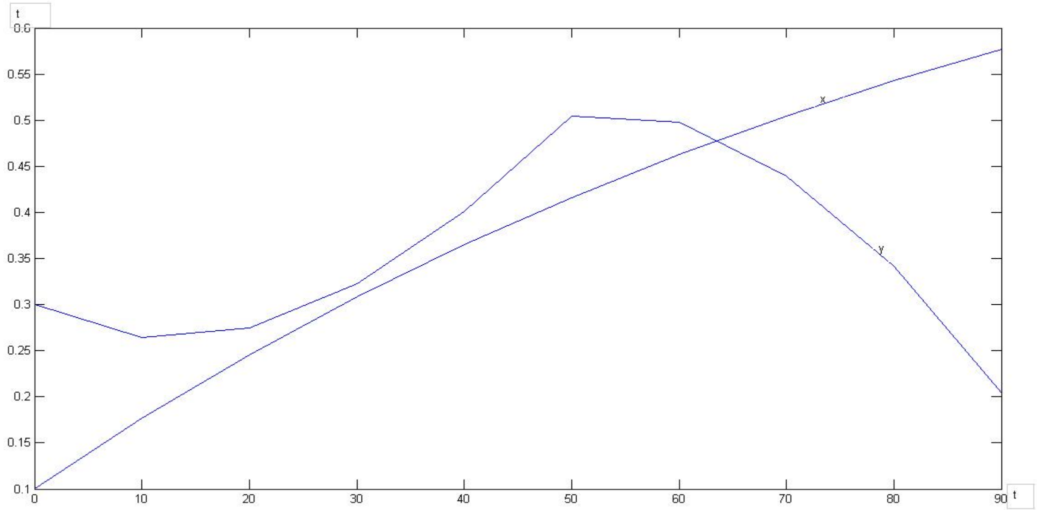

Fig. 2. Graphs of changes in the level of sugar (x) and insulin (y) in the human body calculated by the Euler method

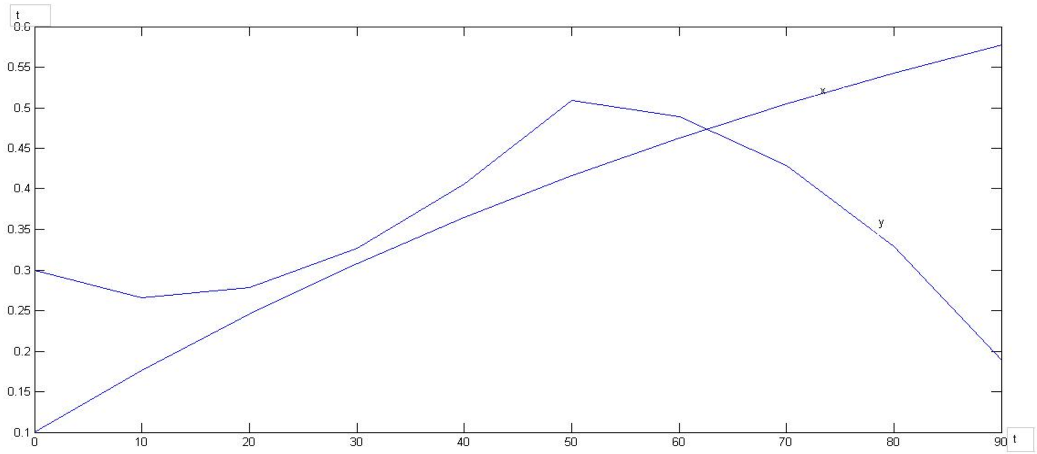

Fig. 3. Graphs of changes in the level of sugar (x) and insulin (y) in the human body calculated by the first improved Euler's method

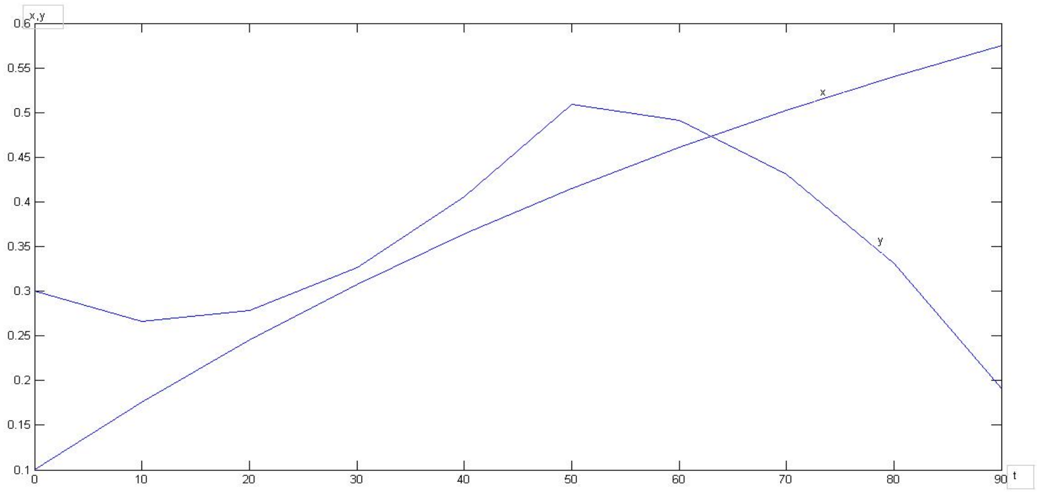

Fig. 4. Graphs of changes in the level of sugar (x) and insulin (y) in the human body calculated by the Runge-Kutta method

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