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Organization of Independent Work on Mathematics among the Students of Biological Department at University Using Information Technologies

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Abstract: With the transition to a bachelor degree the training time reduced and the number of disciplines was not decreased, so the emphasis is on independent work of students to maintain the level of student preparation. The urgency of the problem stated in the study is conditioned by the fact that at the traditional form of independent student work organization in mathematics there are difficulties in the study of this discipline, the lack of study sources of information, etc. So, one needs to organize an independent work properly and efficiently through information technologies. The purpose of the study is to develop methods of using information technology in the organization of independent work of students. The leading method in the study of this problem is a design method aimed at the selection and structuring of electronic educational resource content on the subject "Mathematics" in moodle environment. The developed electronic educational resource for the students of non-mathematical professions includes the following topics: the elements of linear algebra, analytic geometry, mathematical analysis and differential equations. The created electronic educational resource is aimed at the improvement of student knowledge on mathematics and promotes the development of self-employment among students. An experimental study was conducted in 2013-2014, on the basis of biological department at Elabuzhsky Institute of Kazan (Volga region) Federal University. The students of the following areas of training took part in this study: 06.03.01 Biology, "General Biology" profile and 44.03.05. Teacher education, "Biology and Chemistry" profile.

Key words: Independent work among students, mathematics, information technologies, electronic educational resource, geometry

INTRODUCTION

Due to the modernization of higher education and the transition to new educational plans, mathematics is studied in the first semester of Biology faculty. It is necessary to study a large amount of material in mathematics during one semester.

It is almost impossible in a classroom, so some of the issues should be solved by students independently. In our study, we propose to organize an independent work, using information technologies, namely by the means of electronic educational resource created in LMS Moodle environment. Experimental methods showed that an interactive electronic educational resourse influences positively on the organization of independent work among students. This resource allows you to organize remotely the training of students under the guidance of a teacher. An electronic educational resource is made up as a multifunctional source of knowledge which comprises reference material, vocabulary, historical references, lectures, solved problem examples, the problems for independent solutions, tests, control tasks, chat.

MATERIALS AND METHODS

According to the requirements of the 3rd generation of FSES VPO in a university, 50% of the total teaching load is presented by an independent work of students at a high school (FSES, 2015).

An independent work of students is the form of their training activity organization carried out under the direct or indirect supervision of a teacher during which students perform various types of tasks in order to develop the knowledge, skills and personal qualities mostly or completely independently (Andreev, 2005).

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The independent work of students in a classroom is performed under the supervision of a teacher. It is more difficult to organize and manage an independent work of students after school as itsimportance in the development of the program material is very high.

The effectiveness of student independent work may be provided under the following conditions:

- Proportional correlation of classrooms and independent work
- The selection of the necessary methods, forms and means of training for the organization of the student work in a classroom and outside of it in order to turn the process of independent work into the creative process
- Step by step control, the diagnosis and the assessment of knowledge during the independent work among students

The current crisis in higher education does not allow to provide each student completely with necessary educational literature, published in the central publishing houses, so it is necessary to apply modern learning tools.

Mathematics is studied during one semester at the Faculty of Biology. It is not possible to examine all areas of the discipline in full during such a period. The created electronic educational resource in the moodle environment enables students to repeat and deepen the knowledge acquired in a classroom.

Moodle is the course management system, also known as a learning management system or virtual learning environment. Moodle is an acronym for modular object-oriented dynamic learning environment. It is a web application that provides the ability to create sites for online learning (Ganeeva, 2014a).

The development of mathematical formulas in moodle environment is rather complicated and laborious process: you may insert them as pictures, or use the markup language LaTeX. For example, in order to see the mathematical formula:

$$\int_0^4 \frac{dt}{\sqrt{6t+1}}$$

in moodle environment, it is necessary to type $$\int_0^4{dt\over{\sqrt{6t+1}}}$$ in edit mode. The role of information technologies in the process of mathematical discipline study at high school is increased due to the fact that they act as an effective didactic tool with which you may generate an individual educational trajectory of students. This trajectory is the result of personally significant choice of learning content, its complexity, the type of tasks, their qualitative content, the rate of study, etc. (Ganeeva, 2014b).

The technology of electronic educational resources development is considered in the work written by Ustyugova (2011). On the basis of the Kazan Federal University, the lecturers of various disciplines were trained under the program “Theory and practice of LMS Moodle use in training”. These courses allowed many teachers to provide their knowledge not only on study and to create interactive E-learning resources in the LMS Moodle environment.

Each electronic resource is provided with information material which indicates the trend of student training, discipline, the number of hours, the form of control, abstract, keywords, the information about the course author, the date of electronic educational resource commencement, a short course of lectures and the work program of a discipline.

The abstract should contain a summary of the subject under study. The information about author should contain the title, place of work and the author's contact information. A short course of lectures is attached in pdf format, making it possible for a student to learn material and print it. The work program is required that a student was able to learn the basic information about the discipline.

Our electronic resource contains the following resources: reference materials, vocabulary, historical references, lectures, the examples of solved problems, the problems for the independent solutions, tests, control work, chat. References are required for students to remember a correct formula, a constant value for the successful assimilation of new material.

A dictionary or a glossary is an important element of electronic educational resource as it allows you to find quickly the right concept and its definition. The historical reference enriches math with humanitarian and aesthetic content and helps to convince the students on the need to study mathematics and to show the relationship of mathematics to the real world.

The lecture may be composed of several “cards” arranged in series. After studying a card, you may make a number of control issues and continue to carry out an extensive system of transitions from the cards to the issues and back. The examples of solved problems allow to fill the theoretical material with a practical content and provide a model for independent solution of problems.

The tasks for the independent decision making are necessary to consolidate the knowledge gained as the result of independent work with electronic educational resource.

The test is necessary to examine the theoretical knowledge. The test consists of a bank of questions. Types of questions: true/false, short answer, multiple choice, compliance response, etc. A student shall perform a control work in writing and attach the solution to a scanned version. Chat allows to perform a discussion among the participants of the educational process. In a classroom with the students of Biology faculty, we consider the following branches of mathematics:

Elements of linear algebra: The concept of matrix, the types of matrices, addition and subtraction of matrices, multiplication of a matrix by a number, matrix multiplication, inverse matrix concept, finding an inverse matrix (n = 2, 3). The concept of a square matrix determinant (n = 1, 2, 3). Some properties of determinants. The solution of linear equation system (basic concepts). Cramer's rule (n = 2, 3).

Elements of analytic geometry: Plane line, a straight line, slope angle and slope ratio. The equation of the line passing through a given point and a given slope ratio. The line equation passed through these two points. The general equation of a line. Terms of parallelism and perpendicularity of two straight lines. The relative position of two lines, cartesian coordinate system, the polar coordinate system. The relationship between rectangular and polar coordinates and vice versa.

Elements of limit theory and differential calculation: The concept of one variable function. The area of its definition and values. Function schedule methods of function setting, function limit, infinitely small functions and their properties, fundamental theorems about limits. Limit of the function y = sinx/x at x→0 E number. The notion of derivative, function continuity. The links between continuous and differential functions. Geometric, mechanical and chemical meaning of the derivative. The basic rules of differentiation. The derivatives of elementary functions, function differential. The application of differential for approximate calculations. The derivatives of higher orders. Function increase and decrease, function maximum and minimum, convex and concave functions, inflection points, function graph development.

Integral calculation: The concept of a primitive, an indefinite integral and its properties. The table of indefinite integrals, some methods of integration. The substitution of variable in an indefinite integral. Integration by parts; the concept of definite integral, the properties of definite integral, the integral with a variable upper limit, the Newton Leibniz formula. Some improper integrals. The calculation of plane figure areas and the volumes of rotation bodies. Some biological applications of a definite integral.

Differential equations: Differential equations (basic concept), differential equations of the first order (basic concept). Cauchy problem, equations with separable variables. Linear differential equations of the first order. The use of linear equations in biology (the natural growth equation). Linear, homogeneous differential equations with constant coefficients. As an independent work, we put forward the questions of the above mentioned sections and add the following issues for a deeper study:

- The study of linear equation systems
- Homogeneous and heterogeneous systems of linear equations
- Line and plane in space
- Function research and graph development.
- Integration of trigonometric functions
- Applications of a definite integral

The experience in the use of electronic educational resources at the teaching of mathematics is presented in research (Anisimova, 2013; Anisimova and Krasnova, 2015).

RESULTS AND DISCUSSION

We carried out experimental study with the students of Biological Faculty at Elabuzhsky Institute of Kazan (Volga region) Federal University during 2013-2014. Undergraduate students of the first course 06.03.01 Biology discipline, "General Biology" profile of the biological faculty constituted the control group and undergraduate students of the first course, discipline 44.03.05. Teacher education, the profile "Biology and Chemistry" of the biological faculty-experimental group. In order to check the validation of hypotheses, the control activities were conducted in the experimental and control groups to test the acquired knowledge and the practical skills of problem solution.

Table 1: The results of the first test work

Test work no. 1 results								
Task numbers	1	2	3	4	5	6	7	Total
Test group	4.39	4.13	3.96	3.71	2.79	2.63	2.42	23.93
Control group	3.37	3.25	3.41	2.72	2.16	2.03	2.00	18.94
Difference of average	0.92	0.87	0.55	0.99	0.63	0.60	0.42	4.99

To test the student abilities for mathematics problems solution generated during lessons in the course of experiment, two test works were conducted. The first control work was carried out after the study of first two sections and the second one after the examination of the third and the fourth sections. The problems were solved by 24 students of the experimental group (the classes were taught according to the experimental procedure) and 32 students of the control group (the classes were taught according to traditional methods). Let's assume that there are no differences between two groups as a null hypothesis. Let's present the results of the performed control work in Table 1 and Fig. 1.

The solution of tasks by the students was evaluated as 5 points per task. The total maximum amount made 35 points. According to the results of the control work no. 1 in the experimental group a mean value $\overline{X}_э = \overline{X}_1 = 23.93$ sample dispersion value $s_x^2 = 24.86$ and the mean value in control group; $\overline{X}_К = \overline{X}_2 = 18.94$ selective dispersion value $s_x^2 = 60.51$.

The data analysis shows that in this case, the values of averages in the experimental group is higher than the corresponding values in the control group. Let's consider the hypothesis of random mismatch for the average $\overline{X}_К$ and $\overline{X}_э$, e.g., let's show that the variations in the averages are essential ones. Let's use the student's test suitable for the statistical test of this hypothesis Mayer (1997). First, on the basis of individual values comparison let's calculate the estimate of unbiased dispersion σ_*^2 in "summary". For this, the sum of squared deviations of all individual values from the respective average ones is divided by the total number of freedom degrees. Then, let's calculate the Student's t-criterion and the number of freedom degrees:

$$\sigma_*^2 = 45.3;\ t = 2.74;\ \nu = 24+32-2 = 54$$

We obtain the following: $t_{Наб} = 2.74$, $t_{Таб} = 2.7$ (for the probability 0.99), we see that $t_{Наб} > t_{Таб}$. Thus, a null hypothesis is rejected. On this basis, you may conclude that the results of examinations are conditioned by the difference in the education systems with the probability of 0.99.

And after the study of the third and the fourth sections the test work no. 2 was performed. According to

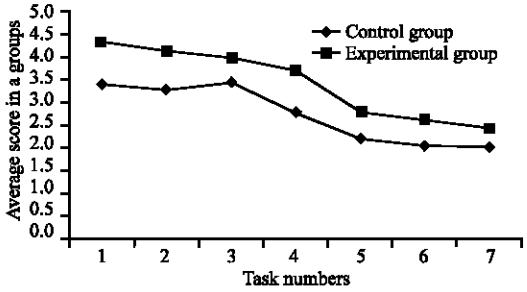

Fig. 1: The result of first control work performance

the results, we may conclude that the experimental group coped better with the test work than the control group, i.e., the knowledge of the experimental group are better.

CONCLUSION

The study outcomes according to our proposed method of independent student work organization for non-mathematical professions evidence of a positive impact concerning information technology use in a classroom and in the performance of domestic and control tasks. Of course, high results of the experimental group were achieved through the use of electronic educational resources created in LMS Moodle environment. An electronic educational resource enriches the theoretical material ofthe subject which is beyond the curriculum, thereby enhancing the ability of independent work among students. Thus, the results of experimental research confirm the consistency of the hypothesis put forward by us.

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