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ON INCREASE OF THE STUDENTS' MOTIVATION AT STUDY OF THE COMPUTER MODELING IN PEDAGOGICAL HIGHER SCHOOLS

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Abstract:

The purpose of the paper is in revealing the psychological and pedagogical peculiarities of educational activity of the pedagogical university students at study of the computer modeling, which allows to raise a productivity of the students' work on the computer models creation; determining the ways of their activization with an accent on application of the computer programs used at school, and the solution of professionally oriented tasks. It is shown, that the increase of the students' motivation can be supported by: 1) informative components of discipline, selection of the science-intensive educational tasks; 2) variability of actions at models creation and computing experiment realization; 3) stimulation of cognitive activity by questions and estimations.

Key words: computer modeling, didactic system, student, teacher, training.

Introduction

The modern teacher should be able to apply the information technologies, in particular, to create and use the computer models in teaching of pupils [1]. Therefore, the problem of formation of the informatics, physics and mathematics teachers' professional competences in the computer modeling classes in the pedagogical university has an urgency [2, 3]. Its solution requires ensuring of the conscious and independent learning, increasing motivation for learning activities, taking into account psychological and pedagogical features of studying the basics of computer modeling by students of pedagogical higher school. Only in this case the students will can go "from reproductive approach in learning to the development of productive creative mental activity" [4, p. 29].

The relevance and urgency of this problem is caused by fact, that despite a significant amount of research on the use of ICT in higher school, they do not create a complete picture of all the psychological and pedagogical aspects of the educational activities of students-future teachers which associate with computer simulations. The purpose of the article is: 1) to identify the psychological and pedagogical features of educational activities of the pedagogical universities students during the computer modeling classes, which allows to improve the effectiveness of students' work on the computer models creation; 2) to determine the ways of the motivation increase with the emphasis on the use of computer programs applied in the school, and the solution of professionally oriented tasks.

Materials and methods

Methodological basis of work are the ideas of Yu. K. Babanskiy, V. P. Bespal'ko, B. M. Velichkovskij [5], L. S. Vygotsky, P. Ya. Galperin, V. V. Davydov, V. I. Zagvyazinskij [6], I. A. Zimnyaya [7], V. P. Zinchenko, V. M. Kroll [8], A. N. Leontyev, I. Lerner, V. L. Matrosova, I. V. Robert, S. L. Rubinstein, L. M. Fridman, A.V. Khutorskoy. To solve this problem we used the methods of pedagogical observation and testing, the method of analysis of the pedagogical situation and methods of mathematical and computer modeling.

The educational activity of the group of students was studied during the computer modeling classes, on which students solved a variety of problems related to the creation of mathematical M-models and computer C-models. The classes were conducted in the computer lab containing 10–12 PCs which connect to a local network with Internet access and have the standard software. The activity approach [7] was used, it bases on the principle: the student should receive knowledge not in a ready form, but to get them independently in the process of his own educational and cognitive activity. The students were faced with a variety of problems: typing of programs and its debugging; the creation of the spreadsheet Excel; execution of the computational experiments; a solution of a series of tasks based on the created program or the electronic tables; the records of task solutions in a copybook. Students solved problems using mathematical and computer modeling methods. The teacher used various strategies of the educational achievements evaluation, the methods of pedagogical observation and testing.

Discussion

An important condition for effective learning is a rise of the students' educational and cognitive activity, an increase their motivation and personal interest in the results. Lack of motivation and insufficient account of the students' psychological and pedagogical features of trainees lead to a decrease in academic progress [9]. Increasing of motivation requires the development of cognitive interest in the studied issues, based on the understanding of the usefulness of the acquired knowledge and skills in the teacher's work, as well as on the use such forms of work with students at which they are interested in improving the effectiveness of training.

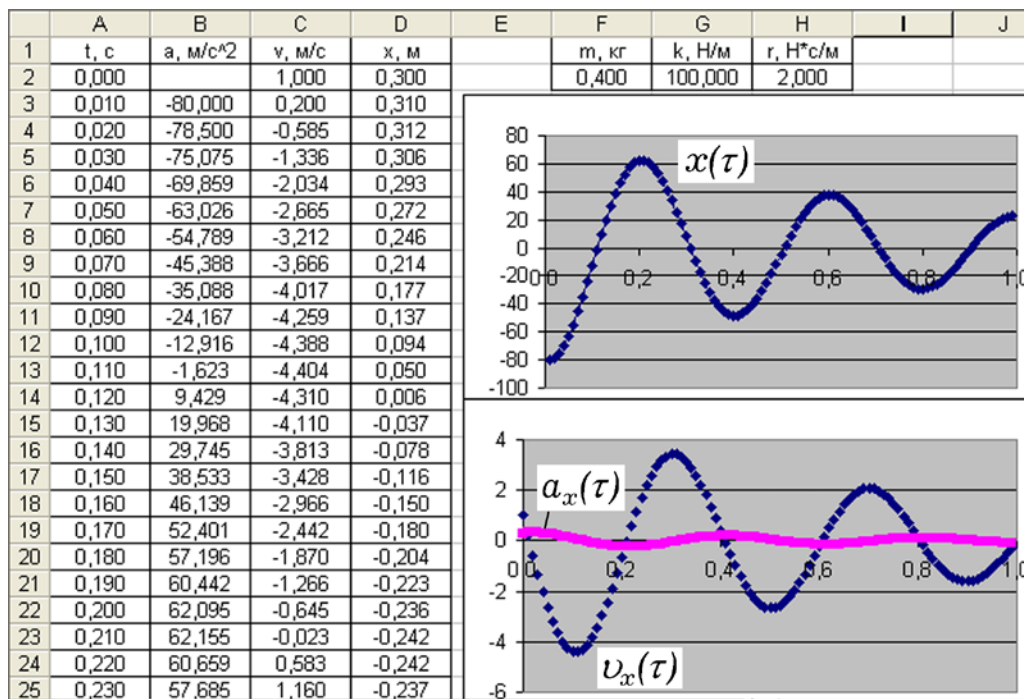


Fig. 1. Simulations of the damped oscillations of the spring pendulum in MS Excel.

1. Motivation by content. The students, who are preparing to become competitive specialists, should feel interest in the studying of the information culture, the formation of skills and abilities of information-educational activities. Therefore, on the computer modeling classes the special emphasis was placed on work with the simple programs that can be used to solve various tasks in their future activities. This primarily refers to the MS Excel spreadsheets, which students can use for calculations and creation of macroses for modeling of the different phenomena. The acquired skills of working with MS Excel because of its universality will be useful in future professional activities. At the same time on the computer modeling classes it is necessary to use Integrated Development Environments (IDE) which allow students to program on high-level languages (Free

Pascal, Delphi, Lazarus, etc.). Pascal language is studied at school, the pupil's ability to create the Pascal-program is tested on the exam, so students are interested in learning it.

It is possible to increase students' interest in the computer modeling by solving professionally oriented tasks related to simulations of various objects and processes studied at school, university or observed in everyday life. These include: the movement of stone in the Earth's gravity field with account of the air resistance force; the electric resonance; the deviation of charged particles by electric and magnetic fields; the calculation of the interference picture in the Young's experiment, the movement of planets around the Sun [10], the modeling of the absolutely black body radiation, etc. For example, in Fig. 1 the modeling results of the damped oscillations of the spring pendulum which calculate in MS Excel are presented. To solve this problem, students used a textbook containing a mathematical model of the phenomenon and the method of the spreadsheet forming [11]. Students, seeing that these curves are very similar to the graphics presented in the textbook, associate this C-model with the already studied theory.

The high speed of the PC makes it possible to quickly solve a complex problem with this or another input data, and to simplify the analysis of the phenomenon under consideration. With help of the C-models the students make a "micro-discovery" at the study of a phenomenon and establish the direction and degree of influence of the various factors on the system behavior, the logical relationship between their magnitude and the response of the system, build trajectories, graphs, diagrams and thereby visualize the studied regularities. It results in growth of the students' intellectual potential, strengthening of conviction in correctness of the theory and modeling methods. The combination of the simplicity, high science saturation, ability to quickly simulate and explore a large number of different situations transforms C-models in the effective tool of study of the environmental world.

The dynamism of some C-models allows to create in the minds of the learners a visual image of the phenomenon, to increase the emotional perception of the educational information that helps to development of the visual-figurative thinking. For example, using the Free Pascal IDE, students simulate the formation of a two-arm autowave in an active medium (Fig. 2.1) and the synchronization of the oscillations of the active medium elements; it connected with the suppression of the low-frequency pacemaker by the high-frequency pacemaker (Fig. 2.2). Visualization of the formation of the space-time structures on the computer screen leads to the formation of correct understanding about the autowave processes that occur in active medium.

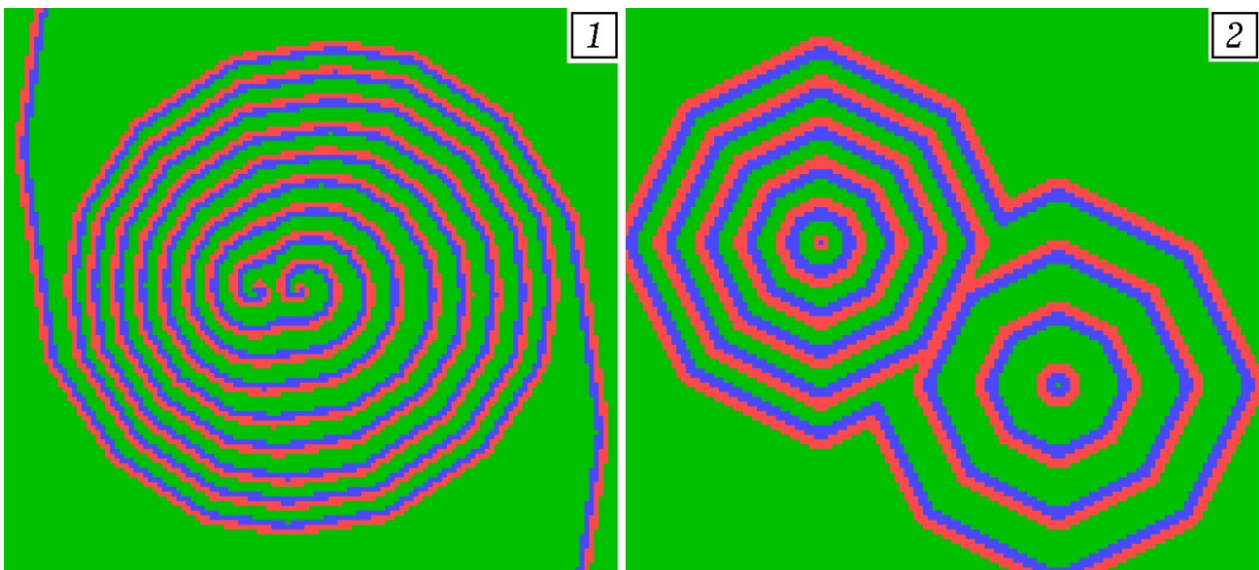


Fig. 2. Modeling of the autowave processes in the active medium.

2. Motivation by process. We used such forms of the classes, in which students were interested in the effectiveness of their activities. Educational tasks were small and simple: at the

beginning of the class the students received the text of the program (or the algorithm of creating an Excel document), which they must type during 10 – 15 minutes, to correct errors and carry out its debugging. Learners solved a typical problem and compared the result with a known one. After that, by changing the input data (the initial conditions, system parameters and external influences), students conducted a series of the computational experiments and wrote the results in a copybooks. Then students considered the next, similar task, which require minor changes in the typed program (or Excel table). Solving the problem, the students recorded the solution in the copybook (5 min): the condition, results (numerical values, graphs, drawings) and conclusions.

On the classes the teacher used: 1. Method of demonstrations: the teacher showed to students how to analyze the system, build the mathematical model, create an algorithm for solving the system of equations and the corresponding program (or Excel document) and with help of projector demonstrated the functioning of the program at different input data. 2. Method of exercises: when the students solved the tasks on the computer, they many times repeated a sequence of the intellectual and practical actions, achieving the formation and improvement of the mathematical skills and specific abilities of interaction with the software. A variety of the educational tasks were used, which corresponded to the capabilities of students. If necessary, the teacher helped to students and corrected errors in the programs. 3. Method of independent work: each student worked on his computer and showed individual activity in the typing, debugging and changing of programs, recording of the tasks solving in the copybook.

In the computer lab students solved problems related to: 1) the proof of previously studied facts and laws that are difficult to justify theoretically, but easy to test on the C-model (for example, proof of the laws of the absolutely black body radiation); 2) the mastering of the computational experiment method (the study of the dependence of the oscillation frequency from pendulum parameters); 3) the study of numerical methods for solving of the differential equations (heat equation, wave equation). Students created spreadsheets, diagrams and graphs, typed a program on Pascal, analyzed the results of the calculations, worked with electronic textbooks, etc. The interactivity of the educational process was ensured through the continuous interaction of the students with the software system, discussion of algorithms, programs and graphs.

During the classes the teacher observed the students' work and evaluated: 1) the speed and correctness of the computer programs typing (or spreadsheets creating) with help of sample; 2) the ability to create new or modify existing programs (Excel documents); 3) the correctness of the computational experiments execution and discovery a relationship between the input parameters and the system response; 4) the quantity of solved tasks, their record in the copybook; 5) the knowledge of the mathematical model methods. For an estimation of the students' knowledge and abilities the rating system was used.

Results

The experience in conducting the computer modeling classes showed that the use of C-models in training has advantages. With their help it is possible: 1) to create visual and dynamic images of the studied phenomena (movement of molecules, rotation of planets); 2) to quickly calculate the dependence of the studied physical value from time or other physical values (for example, the spatial distribution of temperature during heat exchange); 3) to study the dependence of the considered system response from the change of this or that factor (the dependence of the phase portrait of oscillations from the resistance coefficient of the medium); 4) to organize the students' educational activities, in which they acquire the skills and abilities of using computer for solving of different problems and mastering the computational experiment method. Demonstration of numerical solutions of differential equations, calculation of physical fields, modeling of the complex systems have an emotional impact on students, rise the mental activity, lead to interest increasing. Some C-models have a high knowledge intensity: typing of computer program by students (if there is a listing) takes 10 minutes, explanation of the applied method of modeling – 0.5 hours, and carrying out all kinds of computational experiments – 1 – 1.5 hours.

With help of pedagogical observation we found that students learn: 1) to make simple computer programs, which allow to implement a particular algorithm for solving of the given problem; 2) to correctly carry out a mathematical description of the problem; 3) to apply the methods of mathematical modeling; 4) to create an algorithm corresponding to the M-model of the studied system; 5) to create computer programs and implement their debugging; 6) to interpret and explain the simulation results.

Conclusion

The considered approach to the computer modeling teaching in the pedagogical universities promotes growth of students' educational and cognitive activities, creates conditions for increasing the efficiency of the learning process. It is necessary to take into account the following: 1. At work with the students of pedagogical specialities it is not necessary to spend a lot of time on the strict mathematical reasonings. It is better to displace the accent on study of the model creation methods, solving of various tasks of the professional orientation, explanation of used algorithm and results of modeling at a level of school or pedagogical university. 2. The activities approach should dominate on the computer modeling classes: the students receive tasks and examples of typical programs and independently solve the sequence of the given tasks at the individual pace. 3. It is important to focus each student on getting a positive result, to create a situation of success. To do this, the teacher should give the small tasks and examples of the ready-made programs for typical tasks, help students to perform tasks, organize discussion of the modeling results. 4. The intensification of the training activities is provided by: the informative component of discipline, selection of knowledge-based models and tasks for training; the variability of the students' action when they are creating and working with models, carrying out computational experiments; asking the questions for stimulating mental activity and assessments of students' knowledge and skills. It is necessary to pay attention to the importance and urgency of the solved tasks, the strength of the used methods, the capabilities of the studied C-models, the non-obviousness of the results and their connection with the theory studied earlier. 5. The classes should be conducted in a form that allows successful students to assert themselves through fast and correct solution of considered academic tasks. The teacher can encourage those students who type a new program quicker or solve a tasks more correctly. It is also necessary to check the records in the student's copybook and to conduct a test work.

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