

Development of Creative Abilities of Pupils Through Solution Tasks on Physics Using Computer

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ABSTRACT

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Introduction: It is known that nowadays various specialists widely use computer in their work. Today, one can calculate, write, read, edit, study, draw, rework, create audio and video and play on a computer. Its capabilities are increasing day by day, so it has become a person's most reliable friend at work, study, at home, and at leisure.

Objectives: Information technologies in physics teaching can be used in various forms - in preparing presentations, using ready-made educational and demonstration programs, conducting virtual laboratories, solving tasks, etc. The teacher must understand that use of information communication technologies is not only a modern requirement, but also an indispensable condition for achieving high-quality education. His task is to organize teaching that will help increase the effectiveness of education and develop students' creative abilities. For this it is necessary to help students in reflecting, thinking and drawing their own conclusions using computer. Use of computer allows us to create an opportunity to develop students' creative activity and help to teach them solving non-standard tasks by developing independent and logical thinking.

Methods: Processing information sent from spacecraft, controlling the motion of particles in accelerators, and solving complex problems of theoretical physics are unimaginable without computers. Almost all physical problems encountered in life cannot be solved analytically and require the use of computers to solve them. Therefore, every physicist must be able to independently solve problems on a computer, and conducting scientific research in this area is one of the most pressing problems of our time.

Results: In order to simplify the solution of physics tasks on a computer the authors created the "Universal Calculator" program. The program is written in Visual Basic using numerical methods and has the ability to plot an arbitrary function graph, solve quadratic, transcendental and differential equations, calculate definite integrals and process experimental results using the "Least Squares" method. The article provides examples of calculating the path traveled by a body using the program and processing experimental results using the "Least Squares" method.

Conclusions: It is undeniable that information communication technologies are a reality of modern teaching. When computers are used in physics lessons, students participate more actively in the lesson, the attitude to work changes even among the most problematic students, and the teacher is required to master the capabilities of information communication technologies, carefully think over the content of the lesson and plan the work of students at each stage of the lesson.

Keywords: skills, creative ability, information communication technologies, physics lesson, physical task, solution task in computer, educational progress.

INTRODUCTION

As known, at present the life because of the scientific-techniques development of is being puzzled. This situation requires from us to demand making not usual actions but be agility, adaptive thinking, fast adaptation to new conditions, creative actions to solving the great and small problems. The physics develops skills on human thinking

the task's mean, be able the right and logical thinking. The actuality and mean of this theme deal with the developing information society of the XXI century and its high technologies one. Using information and computer technologies opens new possibilities in teachers on teaching own subject, helps in thinking and participating in constructing the lesson elements. In result, they increase on teachers the interests to own subject.

In paper [1] the historical change in the interpretation of the term "gifted" from antiquity to modern scientists, up to the implementation of the presidential program "Gifted Children" in the Russian Federation had been described. The article emphasized that when working with gifted children in physics lessons, it is important to apply methods that promote an in-depth understanding of physical laws and phenomena. The article presented a number of methods that can be applied in physics lessons, as well as their distinctive features and advantages that are not inherent in traditional methods.

The topic of this study is highly relevant in the current pedagogical scientific and methodological context, which is due to the ongoing digitization processes in the education system. In paper [2] the experience of implementing a digital educational resource in the process of mastering by first-year students a philological discipline with a cultural orientation had been analyzed, systematized and transferred. New in the content: the blocks of the author's electronic training course «Russian Oral Folk Art: Folklore and Folkloristics» are described, the experience of constructing educational material and forms of its use had been summarized. Special attention had been given to creative approaches. The results achieved: an innovative author's pedagogical teaching model had been highlighted, it had been proved that the ETC not only enriches the content and methodic of the taught discipline of the curriculum, but also structures both the independent and classroom work of students during the semester.

In the Federal State Educational Standard of Russian Federation, the result of learning in elementary school is the formation of students' "ability to learn", i.e. the ability to solve various learning tasks [3]. Universal Learning Actions (ALA) help a junior schoolchild not only in the educational sphere, but also in life, enabling him/her to independently carry out learning activities, set learning goals, and find and use the means and ways of their realization, controlling and evaluating learning activities and their results. In modern education to achieve their goals traditional methods are moving to the background, as today's junior schoolchildren need active cognitive and to the maximum extent independent activity aimed at creating their own creative products. Therefore, in elementary school it is advisable to introduce technologies based on quick solution of non-trivial tasks. The theory of inventive problem solving, developed by the Soviet inventor G.S. Altshuller, plays a special role in finding creative methods for elementary school students to solve educational problems. Using such technologies, a teacher discovers a great variety of methods that allow primary school students to effectively master the educational material. The lessons have a bright and multifaceted character, as junior schoolchildren learn to compare objects and phenomena of the surrounding world, make various classifications, establish cause-and-effect relationships, as well as reason and argue their position.

In paper [4] scientific and practical approaches to the development of students' creative abilities through solving geometric problems, and presents a methodology for the formation of creative abilities in teaching geometry had been analyzed. The authors considered the conditions for the formation of students' creative abilities by solving geometric problems using the method of additional constructions. The researchers noted that currently schoolchildren have insufficiently developed skills to transform a drawing in the process of studying geometry. This fact underlines the importance of the formation of creative thinking through the development of the ability to see additional constructions when solving geometric problems. Special attention had been paid to the description of the methodology for creating additional constructions in the search for ways to solve the problem. The authors had established a classification of additional constructions depending on the number of elementary constructions.

In the process of teaching the discipline "Technology of organizing independent work", a system of classes had been developed [5], the main purpose of which was to form research competencies among 1st year students. Tasks for students had been designed to develop skills in working with scientific texts, to form an understanding of the need for systematic research throughout the years of study, to participate in conferences and to publish. The received materials can become the basis of term papers and theses. In paper [6] the tasks and stages for formation competitions of foreign business dialogue had been presented. The possible tasks for master students in the law specialty on formation stages of foreign communicative competition oriented to independent work had been listed and described. Author of paper [7] described the advantages of using multimedia and internet technologies in the educational process – in teaching a foreign (French) language in a nonlinguistic university, particular, in organizing student's

independent work. Considered the main types of student's independent work, their interaction with the teacher and global network, presented types of interesting and productive training sessions organized using the internet. It had been concluded that the safe, but at the same time effective, is a combined training format, combining independence and initiative of students and the coordinating, controlling, mediating role of the lecturer.

In paper [8] formation process of the intellect in students on engineering specialties had been analyzed. The development parameters of thinking in educational process had been selected. Interaction of process for solution tasks on general physics and abstract logical thinking of students as formation devices of professional competitions of future engineers had been showed. As a result of studying mathematical disciplines, the student owns the basic concepts, basic mathematical methods and techniques, and is able to solve typical problems [9]. The solution of non-standard, creative tasks, tasks that the student will meet in professional activities, cause difficulties. The reason for this is the lack of experience in creative search for problem solving. In order for students to have this experience, the teacher must create conditions conducive to the development of creative activity. One of such means is the solution of problems with "delayed solution". Such tasks allow you to immerse yourself in the problem, go through the stage of collecting material, accumulating knowledge, moving on to the stage of nurturing the idea of a solution, and then to the stage of insight, finding and testing the solution. In the process of studying mathematical disciplines at a university, a student can learn creative activity in the process of solving problems. These may be tasks for which theoretical knowledge is not enough; tasks that require a combination of already known methods. When solving such problems, the student is immersed in work on individual stages of creative activity. Having gained experience at individual stages, you can move on to independently solving creative, non-standard and other tasks. Tasks with a "delayed solution" create favorable conditions for the implementation of all stages of the creative process.

Professional activity may differ from the theoretical aspects studied by students, so it is necessary to develop their creative approach to solving professional problems. Author of paper [10] considered the types of students distinguished by the way they perceive information (visuals, audials, kinesthetics, digital). The concept of creative approach had been analyzed. The organizational and pedagogical conditions and methods of its development had been studied, the importance of creative skills in the modern world had been determined. The paper presented the results of a study conducted to find out the opinion of students about the expediency of developing a creative approach to solving professional tasks. The conclusions are drawn that many students prefer interactive methods of developing a creative approach, which emphasizes the importance of students' interaction with teachers and with each other. Most students recognize the importance of its development and are aware of the possibilities of its use in future professional activities, while some students are of the opinion that having creative skills is not necessary. In this regard, it is important to work with students' beliefs, to give examples that flexibility and the ability of specialists to find non-standard approaches are currently in demand.

OBJECTIVES

Author of paper [11] argued for the importance of the creative personality of a teacher for modern Russian education and reveals the role of creative abilities of a teacher in his professional development. The main aspects of pedagogical creativity that determine the professional development of a teacher as a creative person had been identified: methodological creativity, communicative creativity, creativity in organizing the learning process, creative self-education. Students of a pedagogical university will allow them to demonstrate pedagogical creativity in all aspects of future professional activity: analytical abilities, the ability to search for alternative solutions to pedagogical problems, the ability to independent and proactive creative pedagogical activity, the ability to cope with situations of uncertainty, the ability to effectively communicate in creative pedagogical activity. The possibilities of "Pedagogy" subject in developing the creative abilities of students, that are future teachers, had been revealed. The potential of the technology of developing critical thinking of students through reading and writing in developing the analytical abilities of students had been revealed. The role of brainstorming, case study method, role-playing games, discussions (debates) in developing the ability of future teachers to search for alternative solutions to pedagogical problems had been substantiated.

In paper [12] a comparative analysis of the concepts of "technical culture", "technical literacy", "technical competence", "natural science literacy" had been carried out from the point of view of the most complete reflection of the idea of the applied orientation of teaching physics. As an implementation tool a system of contextual tasks had been proposed, developed using a task bank for assessing natural science literacy. Tasks had been grouped around

the contexts of “Modern technologies”, “technology in everyday life”. Each group of tasks corresponds to a practice-oriented result expressed in an activity form.

The computer modelling has the own features, that is advantages and disadvantages in comparison of other methods of studying physical systems. The university’s students must be able thinking the digital technologies on learning computer models and different learning objects and using the modern software. The modern computers can solve the difficult equations system in duration of the several seconds, construct graphics of the studying dependence and simulate the hardly making experience. The possibilities of using by pupils and students the different program’s packets such as Mathcad, Matlab, Maple and ANSYS in the physical investigations had been considered by M.D. Suxanova [13].

Organization of the educational activity as the requirement to changing creatively the educational material for learning the new knowledges on students as one of the main tasks is appeared. Integration of information communication technologies to the educational process in the state educational standard of the general education had been noted. It is in compliance with new educational model based on the modern information technologies. Therefore, using information communication technologies in the education process is the actual task of modern education. In the present paper possibilities, advantages and disadvantages for using information communication technologies in the educational process has been discussed.

METHODS

Using information communication technologies in the educational process by teacher not only the modern requirement, but and also the condition of reaching to the high qualitative education. Its task is organization of growing the educational efficiency and teach of helping development of creative skills on pupils. In order to solve this important task, we need the systematic and purposeful development of thinking adaptation of pupils using information communication technologies, stimulation of changing processes and searching activity, study them analyze and conclude own thinking. Information communication technologies allow us to:

- develop intellectual abilities and independent information searching skills;
- use effectively the visual intellection playing an important role in the human life;
- broad the area of the presented information and using the tasks;
- expand the learning activity of students on the lessons;
- realize the individual approach to education;
- self-control on making tasks;
- increase the estimation quality of student’s knowledge and change its shapes;
- provide adapting control of educational process;
- create interests on students as to physics and as learning.

In order to develop the creative skills on students we need develop the representation, thinking abilities and interest to the subject, help striving for perfection from interests to wonderment and active investigation. Information communication technologies organize the system for development comprehensive intellect and creative activity of students and allow their education, help to solve the following tasks:

- development the critical, independent and logical, eristic, associative and false thinking, memory;
- teach thinking through solution nonstandard tasks;
- study to phantasy.

The information technologies in teaching physics can be used in different shapes:

- multimedia lesson presentations;
- using ready-made visual programs;
- electronic lessons and tests;
- extracurricular activities;
- using computers on solving tasks;
- using virtual laboratory works and et al.

Using computer in lessons allows to:

- improve the learning lesson;
- remove the need writing to blackboard of the main stages of the lesson because of the representing them previously to presentation's slides;
- consider the any stage of the lesson because of existence always the need information on students;
- propose using two memory types simultaneously for students which helps the more learn and increase the cognitive interests than the traditional lessons.

Using information technologies in lessons is preferable for students because of they can learn the lesson's material easier and faster than in usual lessons. There students feel emotionally the each of stage of the lesson. The creative activity is appeared from the interest to the subject. In order to develop the cognitive interest of students we must stimulate the activity and necessity to their self-education.

For improving the mood to lesson on the students usually the essential bright and pay attention slides are used. They may consist the mysteries, invitations to games, trips and et al. In order to straightening the knowledge and develop their interest to subjects the independent creative tasks for students having some knowledge on working in computer are proposed.

For developing an attention and discipline in the renewal knowledges stage the many types of the mental arithmetic and automatized physical dictation can be used because of students understand that tasks by machine is giving and repeating or stopping at someone's request ones are impossible. The tasks for students in the first place are represented, then the unknown task them is proposed. The information technologies allow to represent the new material through the different visual aids for explaining the theme. For repeating the previous material, we can use tests. Using tests in the physics lessons allows us to individualize and distinguish of education. Moreover, it helps to enter corrections to educational process, the reliable estimate and control of education quality.

RESULTS

At present reproduction the information sending from a cosmic apparatus, control particles motion in accelerators, carry out super thin experiments, solve the difficult tasks of the theoretical physics to present without computer are impossible. In the other side because of the tasks on the general physics are very simple the numbers of their results are decreased. It is very important for initial learning the physical concepts and laws. It should be noted that almost all the physical tasks dealing with the nature are not solved analytically and because of solve them we use computers. Therefore, each physicist must know to solve independent task through computer and carry out scientific investigations in this field is one of actual problems. Solution of tasks is inalienable part of learn of physics subject. Using electronic calculating machines in solving the physical tasks to following types can be divided:

- programming equations in solving quantitative tasks process and calculation using with electronic calculating machines (in order to use this type as teacher and as pupil must have the required knowledge on the elementary programming);
- check the motion processes dealing to solving results of the quantitative tasks through programming on electronic calculating machines and carrying out virtual experiments (in order to use this type teacher must have knowledge and skills on carrying out virtual experiments);
- present to pupil and solve tasks in the test form using electronic calculating machines (this method can be used effectively in order to fast reveal the pupil's knowledge);
- solve experimental tasks with electronic calculating machines (entering values of the required physical quantities on the electronic calculating machine program allows to observe them through the monitor, that is virtual experiment);
- solve graphical or functional tasks with electronic calculating machines (the possibility for entering values of required physical quantities on program and observe of the resulting graphics in monitor is created);
- solve the logical or qualitative tasks on observing motion and processes in computer.

Creation of competitions for solving tasks by pupils to following stages can be divided:

1. creation competitions to analyze the task's conditions;
2. creation competitions to carry out separate elements of operations for general solving tasks;
3. creation competitions to solve the concrete tasks on known theme;
4. creation skills to construct the algorithms for solving the quantitative, logical and experimental tasks;
5. creation skills to construct the general algorithms on solving the physical tasks.

We propose to carry out following algorithm (operations) in solving the physical tasks on computer:

1. adduction to one system of units of given quantities;
2. reveal the using base laws and formulas;
3. derive the resulting formula or equations;
4. chose the mathematical method;
5. introduce the marks;
6. construct program;
7. calculate in computer;
8. check the result;
9. conclude.

It is known solution of many tasks of physics leads to solution of transcendent and differential equations, drawn graphics of functions and calculation of defining integrals in which usually the digital methods are used. In order to make the solution such tasks in computer easier we constructed the program unit, which "Universal calculator" is called. Because of this unit can work in three languages (English, Uzbek and Russian, there is possibility to reconsnstruct it in other languages too), has "exe" extension and in any computer can be used, occupies very small volume (only 1.2 MB) and also does not require to construct some program text it has the very big scientific and practical meaning.

For example, in order to calculate using this program the defined integral we must enter the corresponding values in the "A", "B", "E" cells of "Defined integrals" section (see, Figure 1), shape of integrand function "f(x)=" then pass "OK" button. Result of calculation of integral in Figure 1 is demonstrated. Here we can see that for calculating integral one enters "0" to "A" cell, "10" to "B" cell, "0.01" to "E" cell, "x" to "f(x)" cell and passes "OK" button the "S=50" result is being appeared.

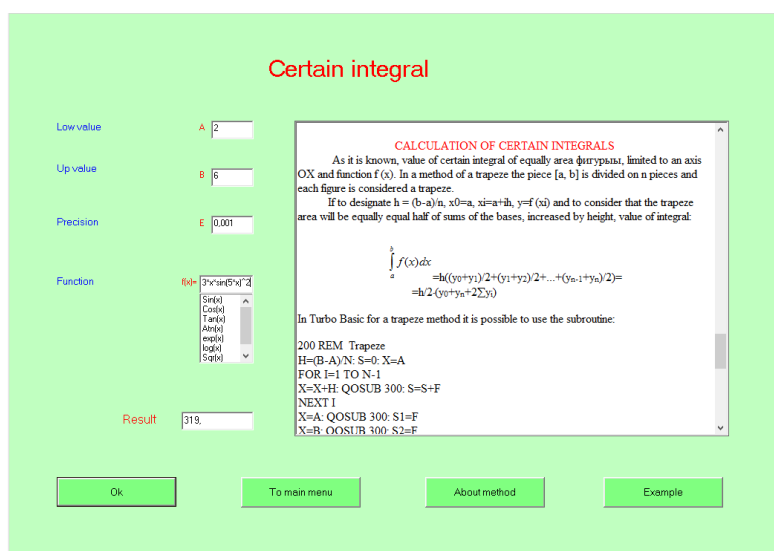


Figure 1. Calculation of defined integral

Task 1. Reveal the distance traveled by body in duration of 2 up to 6 seconds. Its velocity on $v=Ct\sin^2(\alpha t)$ law is changing ($C=3\text{ m/s}^2$, $\alpha=5\text{ 1/s}$).

Solution. It is known the distance traveled by body by representation is defined. In this sample in order to define the distance we shall calculate integral

$$s = \int_2^6 3t \sin^2 5t dt$$

Here let us introduce the new variable $t \rightarrow x$ and enter 2 to cell "A", 6 to cell "B", 0.001 to "E cell" and " $3*x*\sin(5*x)^2$ " to "f(x)=" cell and pass "OK" button. Then we obtain " $S=31.9$ " result (see, Figure 2). This device allows us also to calculate fast and easily the traveled distance in cases of constant velocity, uniformly accelerated and arbitrary motions.

Task 2. In defining the resistor thermic coefficient experiment on the different temperatures, the following results had been obtained.

$t, ^\circ C$	0	20	30	40	50
$R, \Omega m$	2,1	3,2	4,3	5,5	6,8

Reveal the resistor thermic coefficient value.

Solution. It is known that the resistance by this representation on temperature is defined

$$R = R_0(1 + \alpha t). \quad (1)$$

This representation we shall rewrite

$$y = A + Bx \quad (2)$$

(here $y=R$, $A=R_0$, $x=t$, $B=R_0\alpha$) and reveal unknown coefficients using "the simplest quadrates method". Then using representation

$$\alpha = B/A \quad (3)$$

we shall define the thermic coefficient. Introducing 5 to "N" cell and the experimental values from the given table " X_i " and " Y_i " cells after passing "OK" button one will obtain results

$S=0.1$; $A=1.73$; $B=9.44$

Using representation (3) we shall obtain $\alpha=5.46$ (see, Figure 2).

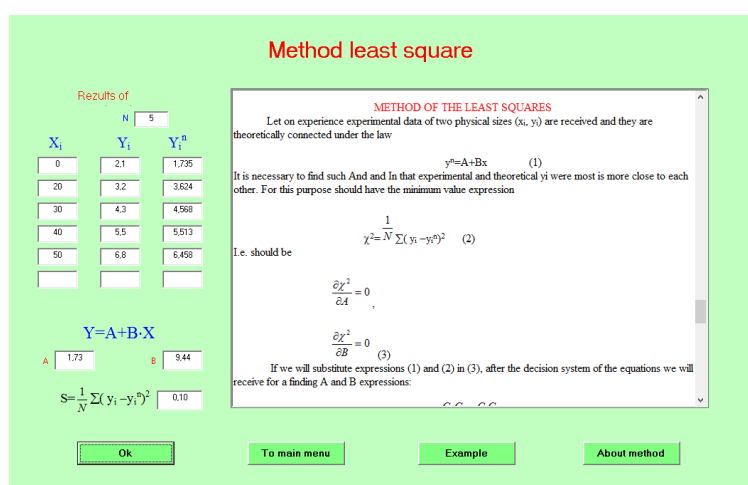


Figure 2. The smallest quadrates method

When we use information communication technologies one must protect to strain and get tired students in the lesson process, plan carefully the individual and independent learning of students, limit by time duration and protect waste unnecessary time. Using computer in the lesson is effective and interesting for students. But we do not used it accidentally. It should be noted that in duration lesson using computer we deal with the following difficulties:

- more time to prepare for the lesson using computer than traditional shapes is spent;
- consequent method for using the multimedia device is absent;
- most educational organizations are provided with these devices not enough.

DISCUSSION

Thus, it is impossible refuse that using computer in the lesson is requirement of the modern education system. When we use computer in lesson on physics then students more actively are participated in comparison of the lessons carrying out without computer. Regard to learning between the most problematic students is changing because of the planning in which study the computer possibilities, thinking carefully the lesson conception and student's study in each stage of the lesson is required. Of course, the learning to the lesson time in the first stage is increasing. But the experience and methodic base are collected consequently which in future makes easier preparing for the lesson. Because of using computer in the lesson, the interest to lesson on students is increasing, they learn more actively and faster. It is important to remember that using computer solves all problems not instantly. Using computers in lesson on physics and extracurricular studying allows us to:

- take into account the individual abilities of students;
- develop the creative and scientific abilities;
- direct students to independent education learning;
- provide high qualitative assimilations of the program material;
- improve quality of knowledges of students on learning of physics.

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