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Chepok Oleg
Sinyukova Helena

INNOVATIVE TEACHING INSTRUMENTS FOR IMPROVEMENT MATHEMATICAL TRAINING OF FUTURE PHYSICS TEACHERS

South Ukrainian National Pedagogical University named after K. D. Ushynsky, Odesa, Ukraine

Abstract*. Conception of practical-oriented teaching-learning process, turned to the concrete results, is among the modern world educational trends. Physics teacher's personal persuasion in a special, mutually penetrative, character of relations between Physics and Mathematics, his ability to demonstrate this character in teaching and educational process and to favor in such a way the formation of analogic persuasions of his students are among the most impotent concrete results of the process of such teacher's, training. A system of mutual co-ordination between the course of General Physics and mathematical courses for the first-year students of physical specialties, together with the author's concept of its implementation are represented.*
Keywords*: Mathematics, Physics, practical-oriented training, mutually penetrative character of relations between Physics and Mathematics, educational curricula, intensive course of Elementary Mathematics.*

It is well known, that any part of Physics as a branch of science and as an educational discipline does not exist without the corresponding mathematical support.

In the history of social development Physics and Mathematics have been forming as a self-dependent fields of knowledge practically during the same time. Each of them at certain periods of its development was a source of inspiration for the other. For example, concepts of natural, integer, rational and real numbers to a considerable extent have on the grounds of the theory of measuring of quantities, in the first place, probably, physical quantities. Such fundamental branches of Mathematics as differential and integral calculus, vector algebra, vector analysis, tensor algebra, tensor analysis have appeared in Physics in search of the most precise descriptions of some phenomena of surrounding reality. Subsequent specification and interpretation by mathematicians the mathematical nature of the fundamental tenets of the branches allows physicists to deepen, to broaden and, sometimes, even to change essentially the character of understanding of the corresponding phenomena as a whole. From the other hand there exist branches of Mathematics (Non-Euclidean geometry of Lobachevsky, for example) that firstly have formed in Mathematics as pure theoretical concepts, and only latter

have found their direct applications in Physics. Verification by practice made evidence the fact, of their being useful for Mathematical description of certain physical phenomena and processes.

Courses of General Physics, Theoretical Mechanics, Theoretical Physics, Electrotechnology and Electronics for future Physics teachers of secondary schools have not only demonstrate examples of applications of mathematical methods but also have to favor the forming students true notion about the indicated mutually penetrative character of relations between Physics and Mathematics.

Conception of practical-oriented teaching-learning process turned to concrete results, is among the world educational trends.

For the process of training future Physics teachers of secondary schools personal persuasion of a teacher in a special mutually penetrative character of relations between Physics and Mathematics, his understanding the necessity and ability to demonstrate this character during his work and favor in such a way the formation of analogic persuasions of his students are among the most important concrete results.

A problem of construction for future Physics teachers of secondary schools a necessary curricular and creation its methodical support is under discussion for a long time now. Works of a lot of researches (K. K. Sominskiy, V. P. Epmakov, O. V. Balina, O. V. Ostrovskaya, L. D. Velichko, N. M. Panasyuk, V. O. Gaydey, N. M. Zaderey, for example [3,4,5,6]) are devoted to the attempts of finding its satisfactory solution.

The purpose of the article is to analyze the curricular of training the first year students that are going to be Physics teachers of secondary schools, to represent some suggestions for its improvement, to discuss the possible variants of the corresponding methodical support on the base of innovative teaching instruments.

The initial parts of the course of General Physics, that are intended to the first year students of the stated specialty, need student's knowledge of mathematical facts and concepts from the content of secondary mathematical education [2,7]. First of all it concerns the following concepts: a real number, identity transformation of mathematical expression, algebraic equation with one unknown variable (linear and quadratic equations including), algebraic equation with two and more unknown variables, Cartesian coordinate system in Euclidean plane and in Euclidean space, real function of real argument and its main characteristics, a graph of a function according to Cartesian coordinate system, specificities of reflection properties of functions by their graphs, the most important properties and graphs of the basic elementary functions, including trigonometric functions, inverse trigonometric functions, exponential and logarithmic functions, composition of functions, first of all composition of the basic elementary functions with the linear functions, graphs of such

compositions of functions that can be considered as the simplest transformations of graphs of the basic elementary functions.

And essential problems appear at once. Mainly this fact is explained by insufficient mathematical preparation of students of secondary schools. The last one, to a considerable extent, is explained by the insufficient quantity of school hours, allotted for studies of Mathematics during the last years of school training. It is quite clear that three or four lessons for a week can't guarantee the necessary deepening into the essence of the subject.

We think that for improving the situation, a special intensive course of Elementary Mathematics must be included to the corresponding curricula.

The course must be intended for a one third part of the first semester. It must precede all physical courses, first of all the course of General Physics. We have to think over the content of such a course and the corresponding forms of organizing studies with great care. First of all the main theoretical facts must be remind (or given, because school textbooks contain a lot of inaccuracies, confusions and direct mistakes). We have in mind definitions precise formulations of theorems together with references to the sources of their proofs and necessary examples.

It is naturally enough to divide the corresponding material into the following modules. 1. Real numbers. 2. Algebraic equations and inequalities. 3. Euclidean plane and Euclidean space. Triangles, quadrilaterals, a circle. Prisms, pyramids, truncated pyramids, right circular cylinder, right circular cone, frustum of a cone, sphere. Areas and volumes. 4. Cartesian coordinate system in Euclidean plane and in Euclidean space. 5. Concepts of a sine, cosine, tangent, cotangent of an angle of rotation. Transformations of trigonometrical expressions. Trigonometrical equation and inequalities. 6. Concept of a real function of a real argument. Main characteristics of such functions. A graph of a function according to Cartesian coordinate system. Algebraic operations of functions, composition of functions.

In contrast to secondary school the presented material as far as it is possible mustn't have an inaccurate, propaedeutic character. Singularities and exclusions have to be of a special attention.

Practical studies must be the next. During them the indicated material must be worked off on the lever of skills.

Presence of the modern information – communicative equipment and its expedient application can essentially improve the efficiency of the course. Thus, in the presence of interactive blackboard and tablets for all the students the corresponding theoretical material may be introduced in the form of presentation which content in a moment reflects and preserves on the tablets of every student (there isn't the necessity in making a summary), for solving practical tasks the student automatically has the necessary reference book in front of him. Working through skills may be conducted by the next scheme.

Firstly some student solves a typical task on the blackboard, the others – make a summary of the suggested solution. The teacher comments the method of solution of the point of view of general theoretic positions, answers the possible questions. Then, with the help of Internet, all students are suggested the same by content but different by figures tasks. Students in turn solve the received tasks on the blackboard. At the same time every other student solves his task in his notebook or in his tablet and sends the received answer to the teacher. In a case of the answer being correct the students may begin to work out the next task, in a case the answer being wrong – he looks for mistake until the next task appears on blackboard. All tasks that have not been solved during the study are left as a hometask. The suggested approach to the organization of a practical study admits the subsequent personalization of teaching with the help of complicated tasks for students that have successfully coped with the necessary minimum of tasks. At the end of every module it is advisable to offer to students same complex control work. Such work must contain as theoretical, as practical tasks. Both types of tasks must be in two forms – in a form of tests and in an open form. At is quite clear, that carrying out the process of training in the suggested form needs from teachers a rather complicated preparation. At the same time approbation of the suggested methods of teaching, that have been realized at one time in a paper form, allows to state, that such methods are able to improve the quality of student's mastering the suggested material nearly by 50 %.

We mean that, simultaneously with such intensive course of Elementary Mathematics, the first year students, that are going to be Physics teachers of secondary schools, will start to master a course of Mathematical Analysis and the integrated course of Linear Algebra and Analytical Geometry.

It is obvious, that content of the suggested intensive course of Elementary Mathematics must be carefully coordinated with the content of the course of Mathematical Analysis. The last one, for example, has to start with the theory of sequences.

The integrated course of Linear Algebra and Analytical Geometry for students of physical specialties has existed in high school already for nearly fifty years. But, methodical questions about it's the most optimum content and structure have not been solved yet.

It is obvious, that mutually penetrative character of relations between Linear Algebra and Analytical Geometry has formed theoretical pre-conditions for the creation of such a course. But it is difficult to recognize it satisfactory the known examples of realization this pre-conditions in teaching – learning practice.

Usually just algebraic questions of the course forms it first part [1]. And by objective reasons it can't be limited only by questions of linear algebra. It is impossible, for example, to introduce the conceptions of linear vector space without the conception of a group and a field.

At the same time, according to the needs of the course of General Physics, that is planned to be the following one and, during some period, parallel to the course under discussion, it is more expedient to start with vector algebra, that forms the beginnings of the traditional nowadays course of Analytical Geometry. Then there is a sense to consider a theory of matrices and determinants, elements of the theory of sets, concepts of a group, a field of real numbers, concepts of an arbitrary affine coordinate system in Euclidean plane and in Euclidean space, of the essence of coordinate method as a main method of Analytical Geometry, a theory of geometrical images of the first and the second order in Euclidean plane and in Euclidean space.

We think that suggested consequence of mastering mathematical courses and their separate themes can guarantee more or less adequate base for the course of General Physics, mastering of which is planned to start only by finishing the course of Elementary Mathematics.

The problem is in fact, that all this is not enough. Standard course of General Physics needs the students of the first year of studies to be profound in the theory of differential equation and the ground of statistic method of treatment physical experimental results [2,7]. And no one of mathematical courses for the first year of studies can't already guarantee such knowledge.

Physicists nothing else are left but to simply indicate the necessary formulas. The corresponding mathematical theory will be given later it will have already preceded the course of Theoretical Physics.

The author’s propositions for the directions improvement the curricular of students that are going to be Physics teachers of secondary schools have been discussed on the conferences of teachers of Physics and Mathematics of South Ukrainian National Pedagogical University named after K. D. Ushynsky. The common opinion was the next. All propositions are interesting and actual. It makes a sense to conduct the corresponding pedagogical experiment. But such experiment needs the corresponding methodical support thoroughly to be worked out.

Conclusions. The problem of improvement mathematical training of students that are going to be Physics teachers is a component of the general problem of improvement the process of training of such students. The innovative teaching instruments provide wide opportunities for solving the both problems on the presence stage of scientific and technical progress successfully. Suggested system of mutual coordination between the course of General Physics and mathematical courses for the first-year students of physical specialties together with the corresponding concept of its implementation may be considered as a possible step in the mentioned direction.

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