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Programming as a Method of Forming Mathematical Knowledge in Conditions of Informatization Education

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Abstract

The article presents the arguments in favor of the active use of programming as a modern method of formation of mathematical knowledge.

Today it is possible to implement the previously invented algorithms in a variety of virtual environments, whether it is a programming environment or specialized system of computer mathematics. That is what opens the way for each student to find and implement solutions is not one particular, but a whole class of problems, empirical confirmation of the already known truths and to promote and test new hypotheses.

This allows you to shift the emphasis in mathematics education with the establishment of computer skills and some limited training with a pencil and paper (chalk and blackboard) toward the use of various computer computing systems, not only as a tool environment to simplify the quantitative and qualitative studies of various processes and tools for release time from routine calculations on the research part of the problem, but at the same time, and as an instrument of knowledge, a monitoring tool and a tool to develop their own mathematical knowledge.

Examples are given of the use of programming ideas in solving problems of some mathematical courses. Attention is accented on a using these ideas in the preparation of mathematics teachers as the main link in the mathematical education system.

Keywords: mathematical training; programming; method of mathematical knowledge formation.

Stop teaching calculating,
Start teaching math.
C. Wolfram, july 2010

Introduction

Specialist preparation today faces with great challenges: we are talking about the active and all-round information society, trends of an active using information content by youth [1], but do not observe the burst of production new knowledge in contrast to the exponential growth data set; today we can not to deny the fact of usefulness and relevance of modern technology and

accompanying software, but it is perceived as a tribute to the era, and not as the cause of and the basis for the necessary reform (update, liquidation, reformatting) established institutions.

It is primarily concerned with the education system, which is the former Soviet Union absorbed a lot of good, but it remained somewhat "unwieldy" and "unreceptive" to the needs of the society, frozen in the materials and methods of the past and the last century. Vivid example is the training of specialists in the field of mathematics inter alia math teachers, whose training is based on updated, but not modern curricula and ever-improving techniques that attempt to incorporate the latest innovations in the form of involvement of information and communication technologies, but still do not have time form completely and remain incomplete for a qualitative leap in the field of mathematics education. This is what at the present stage gives rise to the constant search for methodological research in the field of mathematics teaching and training in the context of the modern information society.

Reviews of related literature

Analysis of the former Soviet Union conference materials in recent years, publications of the leading journals in the field of mathematics education shows trends in the formation of new industries in the field of mathematics that arise at the intersection of mathematics and computer science through the development of this sciences as well as the rapid expansion of the role of information technology in the information society - computer mathematics, informatics mathematics and Mathematical computer Science [2], [3], [4], [5], [6]. Disputes concerning the specification of the content of new industries (which is their subject, and what will be used at the same methods and equipment) are the subject of many of today's scientific and methodological research. But there is something in common, which is characteristic for each of these areas - the presence (visible or invisible) programming ideas, which is used, for example, in automate calculations, converting cumbersome calculations, generalized to high humidity and visualization solutions to various classes of problems, etc.

We believe that it is programming today especially contributes the formation of conscious mathematical knowledge in the preparation of specialists in each field of science, (mathematics, physics, chemistry, computer science, etc.).

Arguing that.

Today it is possible to implement the previously invented algorithms in a variety of virtual environments, whether it is a programming environment or specialized system of computer mathematics. That is what opens the way for each student to find and implement solutions is not one particular, but a whole class of problems, empirical confirmation of the already known truths and to promote and test new hypotheses.

This allows you to shift the emphasis in mathematics education with the establishment of computer skills and some limited training with a pencil and paper (chalk and blackboard) toward the use of various computer computing systems, not only as a tool environment to simplify the quantitative and qualitative studies of various processes and tools for release time from routine calculations on the research part of the problem, but at the same time, and as an instrument of knowledge, a monitoring tool and a tool to develop their own mathematical knowledge.

Researchers agree that the decision of a large number of similar problems affect the quality of mastering mathematical knowledge or skills in the direction of improvement. We agree with the ideas outlined in [7] that programming can be a learning tool that allows you to get away from the routine (often formal) calculations and use a proper "understanding of the essence" for the construction of the required algorithm. We argue that the ability to build a block diagram of a decision or to write the code of the algorithm, or record the correct ordered list of commands in a certain specialized shell is now qualitatively more useful mathematical neoformation than to solve a specific problem with a specific set of input data. This is what gives us the right to say that the use of modern specialized programs (SCM packages dynamic mathematics and other virtual environments), providing for the possibility of programming can simultaneously act as an instrument of knowledge, control and development for everyone.

Conclusion

In favor of the last statement we describe our experience in the use of programming as a method for the formation of mathematical knowledge (programming ideas using SCM Maple reflected our part in [8-11]).

1. The problem of finding the root of an equation with one variable is the typical course of Computational Mathematics. Its solution involves the use of methods already become classical (dichotomy, tangents, secants, chords, etc.), which have already been implemented in the procedures and functions of specialized computer systems. To receive an answer, you can attach tabular processors, the system of computer mathematics (SCM), etc. But the ability to find an answer using the computer tool, today it is necessary but not sufficient for understanding the essence of a numerical method for verifying the root, because this problem is not only from the standpoint of classical science of mathematics, but also important in the context of the preparation of the future teachers of mathematics. The ability to calculate with a paper the iterative approach characterizes the quality of mathematical knowledge, but does not correlate with the hardware and software developments of modern society.

Typical problems is reduced to the construction of the model, the search method, the construction of the algorithm, computation and analysis. Traditional approaches are forced to divert most of the time for computing - the number of iterations must ensure the accuracy of the approximations, but not every method gives the desired error quickly, so the same type of calculations delaying time, and without obtaining the numerical answer is not possible its analysis. Today, the development of software today is so successful that not only count, but also to simulate the situation of approximations for the different methods and their subsequent comparison, programmed calculations and visualize the results, and then analyze it. The ability to do this by means of a virtual environment is characterized not so much knowledge of the orders, as understanding of the mathematical problem and methods for its solution and the quality of mastering mathematical knowledge.

Therefore, we put forward specific requirements for the implementation of methods for finding roots of the equation, which is not only necessary, but also in demand as one of the most important skills of the future specialist. In the study of this course, we offer students to not only make their own algorithms for finding solutions to a variety of methods to visualize them through a combination of construction procedures or functions, but also use it for a variety of computer shell (spreadsheet, some programming environment - a programming language, there may be any, the system of computer mathematics).

In this case, the programming can be regarded as an instrument of cognition, as we study various methods and their speed to ensure accuracy and as an instrument of control of learning.

2. Ideas and methods of in number theory are often used to solve problems in mathematics, starting from secondary school. Therefore, we take this section as clearly necessary in the preparation of teachers of mathematics. Many tasks of this branch of mathematics solved in SCM using one or two orders, but it does not give an opportunity to check the quality of the generated knowledge in contrast to the requirement to construct an algorithm for solving the problem and implement it in a shell. Typical examples of this branch of mathematics in the context of the preparation of teachers of mathematics are the problem of finding prime numbers to a given interval, finding all divisors of the prime factors of the number, the number of the canonical decomposition, finding GCD and LCM of numbers, etc. We also believe that when the student demonstrates an understanding of the essence of the problem and the method to solve it on paper, and it should be able to program a solution to any of accessible virtual environment. If this understanding is not, then we assume that the student has not formed a high-quality knowledge in the field of in number theory, and in this case, programming acts as a tool of control.

In solving this type of problem, we suggest the use of a variety of programming environments, as well as SCM.

3. Analytical Geometry is one of the fundamental disciplines as in the study of the course of higher mathematics, and during the preparation of the future teachers of mathematics. Understanding of the methods of this science is a prerequisite for mastering the many other sections of higher mathematics and at the same time show "spell out" solutions to the many problems of school mathematics.

In the study of this discipline, we believe it is possible to attract programming ideas, such as the formation of skills to determine the relative position of the direct and (or) planes, in the study of the classification based on invariants of curves and surfaces of the second order, etc. We also offer for students research projects which are devoted curves of the third order, which means the study will contribute to a SCM including new knowledge in the field of mathematics. At the same time, we offer using as a specialized programming environment, as SCM. Programming in this case can be a tool of cognition, control and development.

4. Linear algebra allows generating knowledge to work with vectors and matrices. Analogue of these objects in the classical programming perform some data arrays (one-dimensional or two-dimensional). Therefore, we believe that the study of using of linear algebra software for common tasks is also a mean to implement the inter-subject relations between Informatics and Mathematics. In the study of this discipline, propose to use programming environment and SCM, although the latter have a sufficient number of "algebraic" tools for solving problems including determination of the dependence vectors, the determination of the characteristic elements of the matrices, etc. Programming in this case perceive as an instrument of control and development.

5. In the study of differential geometry visualization tasks of motion tangent to the plane curve, the Frenet frame, restoring its natural curve equations, finding the point on the surface type, etc are interesting in the context of the use of programming as a method for the formation of mathematical knowledge. Using SCM is not only simplifies the calculations, but also perfectly visualizes the result that stimulates learning and scientific research. In this case, we perceive programming as a tool for learning, monitoring and development.

These and other problems as our experience shows that imply the use of programming as a mean of forming high-quality mathematical knowledge. These arguments demonstrate not only the two interdisciplinary communication sciences (mathematics and computer science), but also reflect the possibility of improving existing methods of teaching mathematics, designed to promote a higher level of understanding as essentially a mathematical problem and possible ways to solve it.

Recommendations

However, we understand that the active use of software in the mathematics teachers preparation in the professional training faces with a number of challenges, among them - the lack of sufficient material and technical base of universities, a significant reduction in classroom hours to study each of the disciplines in the profile, frequent unwillingness or banal lack of free teachers time to learn modern mathematical software, etc.

However, despite these difficulties, the Ukrainian state and society as a whole raises the question about the need to reform teacher training in mathematics. We see such reform in shifting the traditional emphasis in mathematics (as a rule, skills calculate or simplify) towards the active use of the programming ideas that will reduce the role of the computational aspects of the learning process and lead to a qualitatively new level of understanding basic mathematical ideas and processing methods of the quantitative data that we encounter in everyday life.

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Программирование как метод формирования математического знания

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Аннотация. Сегодня есть возможность реализации придуманных алгоритмов в различных виртуальных средах, будь то среда программирования либо специализированная система компьютерной математики. И именно это открывает путь к поиску и реализации решения не одной конкретной, а целого класса задач, что позволяет сместить акценты в математическом образовании с несколько ограниченного обучения с помощью карандаша и бумаги в сторону использования мощных вычислительных систем, причем не только как как инструментальной среды для количественных и качественных исследований различных процессов, но в то же время и как инструмента познания, инструмента контроля и инструмента развития собственного математического знания.

В статье приведены аргументы в пользу активного использования программирования как современного метода формирования математического знания. Приведены примеры использования идей программирования при решении задач некоторых математических курсов. Акцентировано внимание на использовании этих идей в подготовке учителя математики как основном звене в системе получения математического образования.

Ключевые слова: математическая подготовка; программирование; метод формирования математического знания.