SOFTWARE MODULE REPRESENTING A GEOMETRY TASKS IN MATHEMATICAL SYSTEMS OF EDUCATIONAL APPOINTMENT

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Abstract. The article describes the main functional features of mathematical systems for educational appointment. A short description and analysis of existing and most frequently used mathematical systems of educational purpose with geometry. The main functional requirements for the software module for representing tasks with geometry in mathematical systems for educational appointment.

Keywords: Systems of computer mathematics for educational appointment, mathematical systems for educational appointment, educational process, procedural knowledge.

1   Introduction

The current development of information technologies and communications in the society continuously influences the development of the information environment in educational institutions. The interaction of the educational environment of the edu-cational institution and information and communication technologies create a quali-tatively new constantly updating system. The task of a modern educational institu-tion is to effectively use new opportunities for scientific-methodological and organi-zational-educational work.

One of the most popular means of teaching in the modern period of in-formatting education, which is used in the practice of teaching various disciplines, and in particu-lar mathematics, are electronic educational tools.

Particular attention deserves a description of the unique capabilities of the means of new information technologies, the implementation of which creates prerequisites for the unprecedented in the history of pedagogy, the intensification of the educa-tional process, as well as the creation of techniques, focused on the development of the student's personality. Such opportunities include feedback, visualization of edu-cational information, easy access to archives with scientific guides, methodological support and scientific periodicals, automation of information retrieval processes, organizational management of academic activities and knowledge quality control, etc.

Studies in the field of globalization, informatization of education, creation and ap-plication of informatization in pedagogical activity were conducted as domestic ones

(V. Bykov, M. Zhaldak, O. Kolgatin, V. Lapinsky, L. Petukhova, O. Spiva-kovsky, M. Lvov, V. Peschanenko, O. Spirin, etc.), as well as foreign scientists (V. Grinshkun, N. Elistratova, E. Mashbits, V. Monakhov, P. Obraztsov, I. Robert, D. Sevidzh and etc).

The emergence in the market of professional systems of computer mathematics (PSCM) has led to their intensive introduction into the educational process and numerous pedagogical studies on the use of PSCM in the process of teaching subjects. As a rule, in order to support practical classes, methodists recommend using universal systems of computer algebra (SCA) - Mathematica, Maple, Derive, Mathcad, etc. There are numerous educational and methodical literature on the market devoted to the use of these software systems in the educational process. However, from our point of view, the use of PSCM in the educational process is somewhat limited. Exist-ing PSCMs are intended for solving mathematical problems, while PSEA in mathe-matics must support the course of solving mathematical problems. Accordingly, there is a need for analysis of existing mathematical systems, their functional features are determined, as well as in the design and development of software in accordance with the requirements. Partic-ular attention, in accordance with the task of our study, will be attached to the functional requirements for the program module for the represen-tation of problems in geometry in the MSEA.

The work is a continuation of the scientific research of one of the authors of the article [6-9], as well as the scientific group of KSU [10,11], which is a team of co-authors of the program developed by the Ministry of Education of Ukraine for design-ing educational systems for mathematics - an integrated environment for studying the course "Analytic-on-geometry" , Program environment "Systems of linear equations", Program-methodical complex "TermM VII" support of practical training mathematical activity, Program tool "Library of electronic visualizations Algebra 7-9 class for the general educational institutions of Ukraine ", software for educational purposes" Alge-bra, Grade 8, "Software tool for educational purposes" Algebra, Grade 7 "and others.

2 Mathematical systems of educational appointment. The main functional features

Some computer courses in mathematics are based on the ideas of programmable learn-ing, although they use modern hardware and software capabilities of computer technol-ogy, as well as new methods for presenting knowledge. The most developed and devel-oped methodological and technical point of view in this approach is the lecture part of the course. The problem of adequate support for practical classes in mathematics is often given much less attention. At the same time, the very practical classes make up the largest part in the methodical system of teaching mathematics, which is the most important in content. Of particular note, therefore, is the problem of maintaining prac-tical mathematical activity.

The formation of specific skills and abilities is carried out according to the principle of activity based on the selected material. And it is necessary to take into account the psychological age characteristics of students, the ability to focus on mental problems that require the construction of a response, and not just mechanical memorization.

In the global software market, there are several functional types of specialized software for mathematics training. Firstly, it is educational programs such as electronic textbooks that offer users the teaching materials and testing systems of acquired knowledge. Secondly, it is software tools for supporting the user's practical work on computing, geometry and graphic construction. Thirdly, it is a step-by-step solvers of educational tasks. The best specialized software can combine some of the specified functional types. Nevertheless, each of these software is focused on separate stages of the educational process and certain categories of participants in the educational process.

One of the most important aspects of maintaining a student's practical mathematical activity is to check the correctness of his actions at various stages of solving the problem - from the stage of constructing a mathematical model to the stage of checking the correctness of the course of the solution or the answer. The second, equally important aspect of support is the automation of routine operations related to the calculations. The third aspect is to provide the student with a convenient system of prompts at various stages of solving the problem in the form of generating a mathematical model of a task, the course or step of its solution, the answer.

Practical mathematical activity of the teacher should also be supported. The first aspect of such support is checking the correctness of the decision-making process. The system must verify the correctness of the solution to the problem previously solved by the student (test check mode).

The second aspect of teacher support is the automation of student knowledge testing. A special activity environment must verify the knowledge of the basic mathematical rules and formulas (special testing using mathematical tests).

A prerequisite for the effectiveness of the system of support for practical activity is the possibility of using the training material planned to be supported in accordance with the requirements of the curriculum, a system of training materials supporting practical work with the possibility of its modification.

The system should also ensure the effective conduct of the educational process as a whole, supporting the interaction of the teacher and student.

Consider the main components of the MSEA:

1. **Solution environment**. The course of the solution is a sequence of steps, on each of which the user performs some transformation of the mathematical expression - the model of the mathematical problem. Thus, the Solution Environment is the main program module of the system. The main functions of this module are checking the correctness of the conversions made by the user, automatic conversion on the user's command.
2. **Directory**. The program module provides a list of permissible transformations; The user at every step selects the desired conversion. Editing and transformation of mathematical expressions is supported by a specialized mathematical editor.
3. **Tasks** - program module, which presents all types of tasks that can be solved in the solution environment.
4. **Notebook**. Solved and solved problems are stored in the user's notebook, which is represented by the program module.
5. **Manual**. The manual presents educational theoretical material.

6. **Exercises**. The system of exercises for self-testing, which is implemented in a special program module.

3   Review and analysis of existing MSEAs in geometry

The analysis of the software market for teaching materials from the exact and natural sciences shows that most computer courses in mathematics, physics and other disciplines have a traditional structure and function, that is, they are based on general ideas and principles of programmed learning, although they use all hardware and software. software capabilities of modern computational techniques and new methods of presentation of knowledge.

Here are some software of this type, created by order and recommended by the Ministry of Education and Science of Ukraine:

— Library of electronic visualization "Geometry, 7-9 classes". Institute of pedagogical information technologies.
— Geometry, Grade 7. Institute of Pedagogical Information Technologies.
— Geometry, Grade 8 Institute of Pedagogical Information Technologies.
— Integrated learning environment for the course "Analytical geometry" ("Analytic-on-geometry"). Kherson State University

Of the foreign specialized software of this type we will note the following:

— Geometer's Sketchpad, Cabri Geometry, Cinderella, Geometria, GRACE - Matematical Systems for Exploring Geometry.
— Autograph Graphing Calculator Graphmatica, GraphNow Mathscribe Newt, powerOneGraph - graphic construction systems.

Let's consider in more detail the software that, according to the Internet, is most often used in the educational process and is recommended for use by most educators.

Pedagogical program tool (PPT) "Library of electronic visualization" Geometry 7-9 classes "[2]. The main goal of the PPT is to intensify cognitive activity of students; Strengthen self-sustainability in mastering knowledge, skills and abilities, motivation and interest in learning geometry and, thus, improve student learning achievements.

General features of the package [3]:

1. Organization of computer experiments and researches, nomination and visual verification of hypotheses as a means of maintaining a constructive direction in learning;
2. Modeling of geometric constructions: creation of constructions with the help of computer analogues of compass and ruler, research of received results, measurements;
3. Using the advantages of dynamic geometry is the instantaneous change of all dependent structures by changing some of the output parameters;
4. Illustration of tasks and theorems of the course of planimeter: - creation of interactive tutorials with hyperlinks, hints, dynamic illustrations and multimedia capabilities; - designing and using models for experimenting and solving tasks; - creation of dynamic support notes with comments; - development of directories.

GeoGebra - a program with a universal set of functions for a complete geometric design. Among the main features of the utility can be noted work with coordinate grid, statistical or arithmetic operations, tab-faces, etc.. GeoGebra allows you to calculate the roots of equations or points of extremum and work with derivatives or integral functions. The program contains many tools for setting up convenient mathematical actions. GeoGebra also has the ability to work with two-dimensional and three-dimensional graphs [4].

Program GRAN1 is intended for graphical analysis of functions, from where does its name come from (GRaphic ANalysis). The GRAN-2D program is intended for graphical analysis of systems of geometric objects on a plane, from where it comes from its name (GRaphic Analysis 2-Dimension). The GRAN-3D program is intended for graphical analysis of spatial (three-dimensional) objects, from where it comes from its name (GRaphic Analysis 3-Dimension) [5].

There are numerous educational and methodical literature on the market devoted to the use of these software systems in the educational process. However, from our point of view, the use of PSCM in the educational process is somewhat limited. First, PSCM s are intended for solving mathematical problems, while program system for educational appointment (PSEA) in mathematics must support the course of solving mathematical tasks. Secondly, PSCM in its composition does not contain didactic materials. User manual PSCM can not replace either the textbook, nor the taskmaker on math. Thirdly, the PSCM interface is not targeted at high school students. PMS, as a rule, do not even use a specialized mathematical editor, limited to a line editor with a programmer's syntax. These restrictions can be extended.

The functionality of these software tools is limited to graphic and computational tasks. They do not perform functions requiring symbolic transformations and methods of computer algebra. From our point of view, it is these properties that are decisive for the creation of effective intellectual research in mathematics, physics and other precise and natural sciences.

The most developed and perfect both from a methodical and a technical point of view with this is the lecture part of the course. As a rule, the teaching material of the lecture part is accompanied by systems of control questions and test tasks.

Practical mathematical activity of the student is to solve mathematical tasks. Famous professional computer algebra systems (or mathematical systems) largely solve the problem of supporting professional mathematical activity associated with symbolic calculations and numerical calculations. They provide professionals with the ability to solve a wide range of mathematical tasks. A characteristic feature of such systems is to provide an answer (in the form of formulas or numbers) to the task. Educational mathematical activity, however, has some specificity. The purpose of the student is to construct the process of solving the mathematical tasks rather than obtaining an answer. Therefore, mathematical systems of learning assignment should support the very process of solving a mathematical tasks. It should also be noted that professional computer algebra systems have, as a rule, an English-language interface and are too expensive for use in general education. And these are just some of the disadvantages of professional mathematical systems that make their application in a secondary school virtually unacceptable.

The main purpose of PSCM for educational appointment developed by us is the computer support of practical classes in geometry - that is, the active mathematical activity of the user (student, student). In the process of this kind of activity, the student uses the theoretical knowledge acquired at previous stages of training, to solve practical tasks.

4 Programming module for the presentation of geometry tasks in the MSEA. Functional features.

The analysis of the existing software means that the development of a mathematical educational system with a geometry is relevant, which will meet all the requirements described above. It is especially important to consider requirements for such a program module of a mathematical system as a module for representing geometric tasks.

One of the main software programs of the MSEA for geometry is a programmatic representation of geometric tasks. Which, in turn, should include the following main parts: - the field with the text of the statement, the drawing field, the field of the task " Given", the task solution field, the field for displaying the received response (Fig. 1).
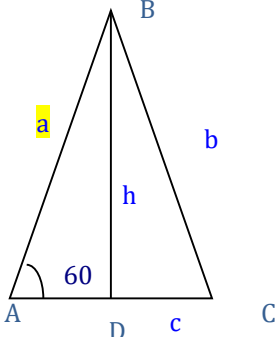

Fig. 1. Software module for representing geometric tasks

Consider in more detail the requirements for each part of the software module:

Creating and editing the condition of the task

The condition of the geometric problem is created (entered into the system) by the user. The user action displays a window, the principal view of which is shown in the figure. The figure indicates the task text field, the number field, the drawing field, the condition field, the decision field, and the task response field. The condition field, in turn, has the Given and Find structure.

In the text field of the task, the task text is imported from the task book, or the text of the new task is entered.

Creating a basic geometric shape

Implemented by the user. Select - Basic geometric shapes
Result of choice:

— display on the screen in the drawing field one of the figures with the notations generated by the "default"
— display the record of the selected shape in the condition field Given
— formation of the basic system of relations in a special data structure Correlations - object attribute.

Edit notation

It is executed by the user directly in the drawing field.

— The point can be marked with a capital letter or a capital letter with an index. The change of the designation automatically leads to a change in the corresponding entries in the condition field and changes in the identifiers in the structure of Correlations.
— The line can be marked with a lowercase letter or a lowercase letter with an index. These letters are the essence of the notation for the lengths of the segments. If the length of a segment is specified in the condition, the user can specify in the drawing this length in the syntax <designation> = <value>. The change of the designation automatically entails the modification of the corresponding entries in the condition field and the change of identifiers in the structure of Correlations.
— The angle can be marked with a lowercase Greek letter or a lowercase Greek letter with an index. These letters are the notation for the magnitude of angles. If a value is specified in a condition for a certain angle, the user can specify in the drawing this value in the syntax <designation> = <value>. The change of the designation automatically entails changing the corresponding entries in the condition field and changing the identifiers in the structure of Correlations.

Construction of basic (geometric shapes) elements

— Construction of a point. Entering a point without adding new relationships to the structure of Correlations.
— Construction of a segment. The construction of two points with the fixation of such new relationships and concepts in the structure of Correlations, as: Length, middle, m / n -point.

— Building a beam. The construction of two points (the first being the start of the ray and the second indicating the direction) with a change in the structure of Correlations.
— Building a line. Construction of two points forming this line + changes in the structure of Correlations.
— Building a corner. For the system, this is the angle between two segments. Can be implemented by two possible options:

- Construction of three points (middle - the top of the corner)
- The construction of two segments and the identification of two points in different sections (one on each)

— Construction of a triangle. Construction of three points.
— Construction of a quadrilateral. The construction of four points.
— Construction of an n-gon. Construction of n points.

At the same time, when constructing a corner, triangle, quadrilateral, n-gon, new correlations and concepts are added to the structure of Correlations. For example, for a triangle, this is (Inequal, Rectangular, Equal-Heave Rectangular (Rectangular Isosceles), Sum of Internal Angles).

- Highlighting one of the main figures

— Select the segment. The segment is selected by specifying two points that define the required segment. Changing the designation automatically involves changing the corresponding entries in the condition field and changing the identifiers in the structure of Correlations.
— Select the angle. The angle is selected by specifying three points that determine the required angle. Change of the designation automatically involves changing the corresponding entries in the condition field and changing identifiers in the structure of Correlations.
— Select the triangle. The triangle is selected by specifying the three points that define the required triangle. Changing the value automatically causes the corresponding entries to change in the condition field and the identifier changes in the Correlations structure.
— Select the quadrilateral. The quadrilateral is selected by specifying the four points that define the required quadrangle. The change of the designation automatically leads to the modification of the corresponding entries in the condition field and the change of identifiers in the structure of Correlations.
— Select the n-gon. The selection of the n-gon is carried out by specifying n points defining the necessary n-gon. Change of designation automatically entails changing the corresponding entries in the condition field and changing the identifiers in the structure of Correlations.

- Additional constructions

Building the main elements without adding new relationships to the structure of Correlations..

- Drawing up the drawing

— Set common and unified requirements for the entire drawing.
— Set your own design for each of the drawing elements.

- Scripts

— Creating a basic geometric figure
— Editing notation
— Building the basic elements
— Highlighting one of the main figures
— Additional constructions
— Drawing up the drawing
— Saving the drawing as an item of the Tasks
— Restoring the drawing as an element of the Task

Conclusions

Today, there are many educational tools. Not a choice and a large number of software systems in mathematics. The analysis of the latter, especially existing systems, allows us to make an understanding of the need for the development of universal software that would include not only theoretical materials and means of test checking knowledge of the student, but also provide the user with the ability to perform the necessary mathematical operations. In other words - they gave the student the opportunity to solve problems in a kind of "electronic book" in the same way as "ordinary" educational process.

The main part of the program module for representing problems with geometry is the designer of the basic geometric figures. All figures are divided into categories and subcategories according to the elements of which the figure will consist. The user's goal is to use a constructor to construct a certain geometric figure according to the condition of the task. The functional of the module will allow displaying on the right side of the screen properties of the fi gure as a whole and the characteristics of all its elements. The data obtained as a result of the work of this module are subsequently used to solve the problem obtained by the student.

The next stage of the work is the implementation and testing of the described module, as well as its implementation in the developed mathematical systems for educational appointment.

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