Modular support system for managing the solution of non-standard geometric problems

Evgrafova Irina Vladimirovna
Candidate of Pedagogic Sciences, Associate Professor, Faculty Dean
St. Petersburg State Marine Technical University

Abstract. The article discusses the issues of solving non-standard geometric problems using a training computer system to support the management of their solution. As a basis for the development of the system, teaching methods are used in the interactive dialogue mode. Attention is paid to learning in the form of finding solutions to problems and, as a consequence, the development of a type of thinking, its transition to a more algorithmic and mathematized level. As an example, typical questions are given for developing a scenario for solving problems.
Keywords: non-standard geometric problems, solution management support system, interactive dialogue, modular system, solution search.

Currently, especially during a pandemic, the use of various training software products is becoming the most urgent. Achievement of the modern level of mathematical education is possible when using the enormous potential of extracurricular work, since only in unity with the compulsory course of studying mathematics, extracurricular activities can create conditions for a more complete implementation of practical, educational, general educational and developmental learning goals. In education, new requirements are being presented to the results of mastering the basic educational program by students. The organization of classes in the areas of extracurricular activities is becoming an integral part of the educational process. This work not only deepens and expands the knowledge of mathematical education, but also contributes to the formation of universal (metasubject) skills and abilities, the development of cognitive and creative abilities and interests and, as a result, increases the motivation to study the discipline.

There are many tutorials for a number of areas of mathematics, but most of them are testing programs. The created version of the proposed computer system allows teaching the solution of non-standard geometric problems, which will be especially in demand when preparing for various kinds of mathematical Olympiads and passing the unified state exam.

The methodology for designing new pedagogical technologies requires the development of training systems that ensure the development of students' creative activity and the introduction of methodological innovations in the educational process. With regard to the problems associated with the development of new pedagogical technologies, the analysis of the possibilities of computer support for various aspects of education is of particular interest. The pedagogical

capabilities of the computer as a means of teaching in a number of indicators far exceed the capabilities of traditional means of supporting the educational process. In order to successfully apply computer learning technology, it is necessary to clearly understand the basic principles and techniques that contribute to the enhancement of human intellectual capabilities [3].

Guided by the methods of teaching in the interactive dialogue mode, proposed by G. Polya [9,10], V.A. Ufnarovsky [11] and N.K. Kosovskiy [7], a computer system was created to support the management of the solution of non-standard geometric problems. This system is primarily intended for students who want to study geometry in more depth.

Often in the classroom of mathematics and especially geometry we hear: non-standard problem, non-standard situation, non-standard approach, non-standard solution. Different authors have their own approach to the interpretation of these concepts. A.A. Carpenter wrote: "When it comes to teaching the solution of atypical problems that require a creative approach, when the learned algorithms are not applicable (do not lead to the solution of the problem), the teaching should orient students to find a solution with the help of some useful recommendations, which, although not of an algorithmic nature and do not guarantee the success of the search, they still contribute to it". Solving non-standard problems is an art that can be mastered only as a result of deep constant self-analysis of actions to solve problems and constant training in solving various problems [8].

Let us call the assumed solutions of the problems control. The support system is designed to familiarize oneself with geometric sophisms and paradoxes [4], and allows the user to find a control solution to the proposed problems in an interactive dialogue with a computer. Mathematical sophism is plausible reasoning leading to an implausible result. Moreover, the result obtained may contradict all our ideas, but it is often not so easy to find an error in reasoning. The paradox by its definition is close to sophism. According to the dictionary of S.I. "A paradox is a strange statement that is at odds with the generally accepted opinion, as well as an opinion that contradicts (sometimes only at first glance) common sense".

In solving each of the problems, there are about ten stages of considering the way to find a solution. Essentially, a multi-stage menu system is used. The system consists of modules of the same type. The creation of a modular system will make it possible to expand it by adding new modules containing the next tasks. Writing the source code of the system in one file, without using modules, will make it difficult to work with it, and when the system starts, it may lead to a lack of computer memory.

For each problem under consideration, its own scenario has been developed, based on the principles proposed by G. Polya and V.A. Ufnarovsky. They consist in the fact that the solution of the problem is divided into several stages, each of which has its culmination with a question

(or advice), which can serve as a concentrated expression of this particular stage. So G. Polya, for example, points out that each of the questions, when asked at the right time and in the right place, can stimulate the right answer, the right idea, a well-directed movement of thought that can move the solution forward. Thus, the question can play the role of a stimulant that accelerates the desired response of the learner. Of course, in some cases, you may not know exactly which question you should ask. But then you can iterate over them from a certain set, one after another, until, in the end, there is such a question that turns out to be useful.

The principle of the scenario is to develop a solution for each problem under consideration, that is, it comes down to creating a system of questions, organized in several menus. Typical questions used in the development of scripts are questions such as [2]:

1. What science can be used to solve this problem?
2. Which of the branches of mathematics is appropriate to use in solving the problem?
3. What does this branch of mathematics study?
4. What shapes are used in this task?
5. How can you characterize these figures?
6. Which of the presented theorems (formulas) should be applied to find the unknown parameter?
7. What will be the solution to the problem considered?

The support system is focused on learning how to find solutions to problems. It allows you to individualize the course of solving a problem. In the process of finding a solution, an average of about ten screens of the interactive dialogue menu changes on the screen. If the user does not solve the problem, this system allows (sometimes by exhaustive search) to obtain a control solution.

After starting the program, the task selection window is displayed in front of the user. When you select a problem, a window appears on the screen containing the wording and picture for the problem, a question and answer options. Depending on the selected answer option, the corresponding comment is displayed on the screen. If you select an answer for which there is no path leading to a solution in the program, the question is asked again. If you choose the correct answer (of which there may be two), the program asks the user a follow-up question. At the same time, the user is provided with service capabilities, including instructions for working with the program, viewing the record of control solutions of the proposed problems, a list of definitions of mathematical terms and formulas, the use of some of which can lead to the solution of the problem, as well as brief information about the program. If desired, you can interrupt work with the program at any time, and exit to the task selection window.

The tools [5,6] of the visual logic programming language Visual Prolog were used as a development environment.

The Visual Prolog programming environment, created by PDC (Prolog Development Center), is based on the powerful logic programming language Prolog. Prolog is a declarative (descriptive) language. This means that given the necessary facts and rules, he will use the deductive method (from general to specific) to solve programming problems. Prolog rules describe the relationship between input data and output, that is, the results to be generated from the available data. Thus, the main task of Prolog is to find the necessary solution to the problem. The universal development environment Visual Prolog has a visual, object-oriented programming environment, a full-fledged database support mechanism. Web development tools allow a system written in Visual Prolog to be connected to Web pages. These capabilities make Visual Prolog a powerful tool for creating training systems with a large coverage of the potential training audience [1].

The system has been successfully tested on students and this gives reason to believe that this system will be able to provide an individual systematization of knowledge for active direct use in training, both with the use of a computer and without using it, using only the developed scenario.

The application of the proposed system in the educational process will allow to consolidate and apply the acquired knowledge in practice. The developed structure of the system can be used for the development of computer programs used to study the basic course of mathematics, as well as to deepen skills in a number of its sections.

Learning in this way is considered as one of the possible factors contributing to a faster and better assimilation of the material. This addition to the learning process will allow you to control each student even with different levels of knowledge, can speed up the learning process and make it more diverse and interesting. Working with a computer support system for managing the solution of non-standard geometric problems can lead to a change in the type of thinking, its transition to a more algorithmic and mathematized level.

References

1. Evgrafova I.V. Analysis of the functionality of ToolBook and Visual Prolog as training systems development tools. Collection of scientific works "Shipbuilding education and science - 2003", V. III. – SPb.: Publishing house of SPbSMTU, 2003., P. 339-342.
2. Evgrafova I.V. Using the Visual Prolog environment to create a computer guiding question system. Interuniversity collection of scientific papers, Iss. 5, "Computer Science – Research

and Innovation". – SPb.: Publishing house of A.S. Pushkin Leningrad State Regional University, 2001, P. 19-22.

3. Evgrafova I.V., Kosovskiy N.K. The relevance of systems teaching problem solving. Journal: "Scientific Notes". Iss. 34. – Moscow: Publishing house of IIO GAN RAO, 2011, P. 88-90.
4. Ignatiev E.I. In the kingdom of ingenuity. – M.: "Science", 1987, 175 P.
5. Ying C., Solomon D. Using Turbo Prolog: Transl. from Engl. – M.: "Mir", 1993, 608 P.
6. Kerov L.A., Chastikov A.P., Yudin Yu.V. Expert systems: Development tools. – SPb.: "Polytechnic", 1996, 220 P.
7. Kosovskiy N.K. Heuristic Techniques in the Scheme for Solving Non-Standard Problems / Problems of Integration in Natural Science Education. – SPb.: 1993, P. 23-24.
8. Malinina I.S.Non-standard tasks in geometry lessons and methods of their solution. – M.: "Science and School", № 5, 2013, P. 108-110.
9. Poya G. How to solve a problem. – M.: "Uchpedgiz", 1959, 320 P.
10. Poya D. Mathematical discovery. – M.: "Science", 1976, 448 P.
11. Ufnarovsky V.A. Mathematical aquarium. – Chisinau: "Shtiintsa", 1987, 216 P.