R. Trofimenko, T. Taratenko

THEMATIC FORUMS «PUPIL DAIRY» AS A RESOURCE FOR SELF-REALIZATION OF CREATIVITY OF CHILDREN*

The paper presents the experience of introduction of special «dairy» for pupils to master their systematic creative thinking. The work was started in 2004 at St.Petersburg Center for Engineering Creativity for Children by the group of enthusiasts includion the authors and T.A.Taratenko.

L. L. Velikovich

INFORMATION APPROACH TO THE THEORY OF PROBLEM SOLVING: FIRST STEPS.

1. Introduction

Let information field contains some element with incomplete information. We'll call this element a problem. And we have to solve it. In other words necessary information has to be restored in accordance with the problem situation.

In this article we present our own approach to these matters.

2. Brief background

My research in the field of the theory of problem solving (TPS) has been inspired by acquaintance with TRIZ in 1989 at the seminars of G. A. Yezersky, who lives in the USA at the present moment. From the very beginning it was quite clear that alphabetic transition of TRIZ into mathematics is impossible, because TRIZ was created as the theory of engineering systems [1] and its methods are inapplicable in mathematics. That's why I had to exert oneself to get the matter moving. I spent about five years to do this, and by the moment I began to write this book [2] I had already had certain groundwork on TPS, which are

* Full version of the article is given in Russian

used in the book for solving various problems. Here are some of them: a wide choice of opportunities, Dragon's effect, MPLI, border effect, cobble-stone effect, basic pattern of problem solving (BPPS), as well as seven principles of reasonable activity: 1) delayed action (the strategy of indirect approach); 2) validity of solution; 3) elimination of false hypotheses; 4) continuity of logic chains; 5) completeness of alternative space; 6) simplicity; 7) systemic solutions.

3. Basis of the TPS

3.1 What is Mathematics?

Mathematics is like a game according to certain rules, which help in building necessary logic chains: A => B => C => ... => E. We have just enumerated seven principles which have to be followed when building those logic chains. Let's add one more. The principle of fractionary of logic chains has significant heuristic importance. Its sense is in the following. As a rule, all the steps in a chain have to be disintegrated and brought to the simplest operations. If to build «a wide choice of opportunities» after each step (i.e. multitude of possible further operations), we will be able to get an extra chance to find some new alternate solutions.

Let's dwell on two main aspects of mathematics.

1. Mathematics is the art of probable.

Problem 1. Express bisector of an interior angle of a triangle through the sides.

Solution. Beautiful solution of this task is based upon the possibility to circumscribe a circle around any arbitrary triangle. But the art itself is to guess to build this bound pair (triangle – circumference)!

2. Mathematics is exploration of operations. The term «operation» will be used as synonym to «action». To solve any task it is necessary to find sequence of operations, which binds problem situation with its conclusion.

3.2 Some of the concepts and designations used

As primary (undefined) concepts of TPS we will accept the following: object, subject, link, action.

Situation is any object set and their links. Minimal situation contains two objects and one link. Visually it can be presented in the form of graph $G=(V,E)$, where multitude of points V coincides with multitude of objects, and multitude of edges E corresponds to multitude of links. Particularly, edge is minimal situation.

Fact is a statement about the availability or unavailability of link between

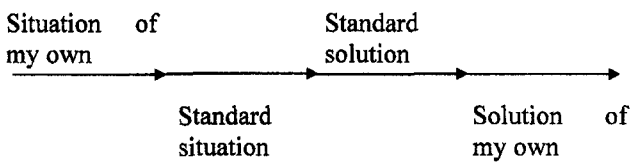
objects. Information is a set of facts. So, each situation contains certain information, which can be retrieved.

Problem is a ranked four (Ω, A, B, X), where Ω is a problem carrier, A is a problem situation (multitude of premises), B is a conclusion (multitude of corollary facts), X is a problem solution as a process of generation of information. Unification of Ω and A, which is the multitude of problem given data, corresponds some multitude of situations.

As a rule any problem is located in a certain specially organized part of an information field which is called a theory. Any theory starts from language, by means of which its main objects and mutual relations are described. It is followed by elementary rules to work with these objects. Then go standard situations, which have to be solved in this theory.

3.3 Basic pattern of problem solving (BPPS)

One of the main tools of TPS is BPPS, which can be presented like this:



Let's show how it works by the way of a simple example.

Problem 2. There's a square, two tops of which lie on the circumference with radius R, and the other two lie on the tangent to this circumference. We have to find diagonal length of this square.

Solution. It's obvious that this square is not inscribed in the circumference and is not circumscribed around it, but connected with it by means of unconventional manner. That is the obstacle. Fortunately, standard situation is evident enough. It will be enough just to connect meet points of the square with the circumference by means of a segment of the line to get a rectangle, which is inscribed into the circumference, and this situation is one of the standard. After that it will be quite easy to solve the problem.

No less important significance has BPPS when building mathematical theories.

3.4 Universal methods of problem solving. Method of bound pairs

All the methods can be divided into universal and specialized. Universal mathematical methods are the following: 1) partitioning into cases (or the way I call it – «the method of alternatives»); 2) reduction to absurdity (or in other words – «proof by contradiction»); 3) mathematical induction and some others.

And now let's consider one more universal method which I have named «The method of bound pairs». Its concept is in the following:

1. Process of search includes search for information decision structure (IDS).

2. Minimal situation is the bearer of base information unit, consisting of two objects and their link – «bound pair» (using terms of the graph theory – edge).

3. IDS is a certain set of base information units with possible course of an edge turning into a point in order to build the next edge.

In fact, we have already encountered this method in the Problems 1, 2. In the first one the bound pair was the triangle and circumference which had been circumscribed around it. In the Problem 2 «bound pair» was the circumference and the rectangle which had been inscribed in it.

Let's make two more simple examples:

Problem 3. Solve the following equation:

$$\left(\sqrt{2-\sqrt{3}}\right)^x+\left(\sqrt{2+\sqrt{3}}\right)^x=4$$

Solution. Relation between these two objects in the left part of the equation is obvious:

$$\left(\sqrt{2-\sqrt{3}}\right)^x\left(\sqrt{2+\sqrt{3}}\right)^x=\sqrt{\left(\sqrt{2-\sqrt{3}}\right)^x\left(\sqrt{2+\sqrt{3}}\right)^x}=1^x=1$$

We just have to suppose that $\left(\sqrt{2-\sqrt{3}}\right)^x=t$ in order to complete the solution.

Problem 4. Solve the following inequality:

$$\frac{x+6}{x-6}\left(\frac{x-4}{x+4}\right)^2+\frac{x-6}{x+6}\left(\frac{x+9}{x-9}\right)^2<\frac{2x^2+72}{x^2-36}$$

Solution. Relation between the objects $\frac{x+6}{x-6}$ is obvious: they are mutually inverse expressions. But unfortunately this relation in this particular problem is useless. But on the other hand, if we try to establish other relation between the

same objects by means of addition we may get quite a useful fact:

$$\frac{x+6}{x-6}+\frac{x-6}{x+6}=\frac{2x^2+72}{x^2-36}$$

and the solution of the problem will become obvious.

3.4.1 Remark

Let's accentuate that in geometry this method of «bound pairs» is used almost everywhere: they are pairs of equilateral triangles and pairs of similar triangles and a point incident to a line, etc.

BIBLIOGRAPHY

1. Альтшуллер Г.С. Творчество как точная наука. М.: Советское радио, 1976 – 175с.

2. Великович Л.Л. Подготовка к экзаменам по математике. Учебное пособие для абитуриентов и учащихся 9 – 11 кл., Ч 1,2. М.: Народное образование, 2006. – 610 с.

H.M. Bakker[**]

CONCEPT OF FUNCTION ANALYSIS WITH CAD SOFTWARE

The goal of this research is to make function modeling together with CAD software easier by integrating function modeling with CAD software and by finding ways to assist users in using it. To demonstrate the resulting principles, a SolidWorks add-in was developed.

Introduction

Engineers often use multiple engineering methods to develop and improve their products and systems. For example, they can analyze and improve their systems using TRIZ and then draw these improvements in CAD software. Software

[**]«Student section of TRIZfest»