
# Methods of solving complex problems and its methodology

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**ABSTRACT**

What should be done if the problem does not come out in one or more studies? What should be the approach to a difficult problem in general? Not only beginners, but also professional mathematicians often face such questions. So far, books on the laws of mathematical thinking have been written based on the experience of strong mathematicians

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What should be done if the problem does not come out in one or more studies? What should be the approach to a difficult problem in general? Not only beginners, but also professional mathematicians often face such questions. So far, books on the laws of mathematical thinking have been written based on the experience of strong mathematicians. Now let's discuss the internal nature of the problems and the common ways to solve them.

Issues that cause difficulties for the student are usually complex in content. Problems that are similar to the one solved before or the same type as the problem shown by the teacher, or solved by a method that has been used many times, although different from the previous ones, are not complicated, they are usually called simple problems. No matter how complex the problem is, it is necessary to search for a new idea, an independent way. The more complicated the problem, the more mathematicians value it.

Every new problem in the history of mathematics was complicated in its time. For example, many treatises have been written about finding the root of a quadratic equation and finding the volume of a sphere with a known radius. With the development of human thinking, rules for solving such problems have been found and they have changed from complex problems to simple ones. To solve such problems, it is enough to familiarize yourself with these rules and practice enough. At the moment, it is often useless to encourage people to solve simple problems without learning how to solve them. At the same time, it is necessary to master the solution of simple problems related to each topic as quickly as possible, and aim to move to complex problems related to this topic.

Let's take the topic "quadratic equation" as an example.

1. $x^2 - 3x - 4 = 0, 3x^2 + x - 14 = 0$ satandart tenglamalardir.
2. $x^2 + (2-a)x - 2a = 0,\ x^2 - 2\sqrt{3x} - 6 = 0$

is also simple, it is enough to be able to perform algebraic operations with only literal coefficients such as 2-a and non-integer coefficients such as $2\sqrt{3}$. In particular, the solution of the last equation:

$$x_{1,2} = \sqrt{3} \pm \sqrt{(\sqrt{3})^2 + 6} = \sqrt{3} \pm \sqrt{9} = \sqrt{3} \pm 3$$

3. $x^4 - 10x^2 + 9 = 0$ (biquadratic equation):

$$4^{x+2} + 7 * 2^x - 2 = 0,\ lg^2x + lgx - 6 = 0,$$
$$2\sqrt{x} + 3 = x, x^2 - 3|x| - 10 = 0$$

- these equations are also simple, because they come to a quadratic equation with a simple method - a new unknown entry. In particular, in the last equation

$|x| = y$ if it is said, $x^2 = y^2$ because $y^2 - 3y - 10 = 0$ quadratic equation. From him
$y_{1.2} = \frac{3\pm\sqrt{9-40}}{2}$; $y_1 = \frac{3+7}{2} = 5$; $y_2 = \frac{3-7}{2} = -2$.
So, the considered equation is a set of equations$|x| = 5$ va
$|x| = -2$ equally strong, that is

$$x^2 - 3|x| - 10 = 0 \Leftrightarrow \left[\begin{array}{l} |x| = 5, \\ |x| = -2. \end{array}\right.$$

From the first equation of the last system $x = 5$, $x = -5$ comes out. Second $x = -2$ and the equation has no roots because $|x| \geq 0$.

4. $\sqrt[5]{(7x-3)^3} + 8\sqrt[5]{\frac{1}{(3-7x)^3}} = 7$ as it looks scary$(3-7x) = -(7x-3)^2$ and $\sqrt[5]{-a} = -\sqrt[5]{a}$ considering that $\sqrt[5]{(7x-3)^3} = y$ if it is said, an almost quadratic equation is formed

$$y + \frac{8}{y} = 7$$

5. $2\sqrt[4]{1+x} + 2\sqrt[4]{1-x} = 5\sqrt[8]{1-x^2}$-bAt first glance, it is not clear which simple method should be used there, but $\sqrt[8]{1-x^2} = \sqrt[8]{(1-x)(1+x)}$ it is obvious. Now it is quite simple to bring the roots to the same index.

$$2\sqrt[8]{(1+x)^2} + 2\sqrt[8]{(1-x)^2} = 5\sqrt[8]{(1-x)}(1+x) \qquad (1)$$

(the expediency of this was demonstrated by performing "no-interest" exercises such as ∜(a^2)=√(8&a), √(n&a)=√(nm&a^m) and mastered the technique of shape substitutions ``only the student can see it.'',

$$2u^2 + 2v^2 = 5uv \qquad (2)$$

We have the following equation. Can it be divided into multipliers? Can it be reduced to a quadratic equation? So what if we solve the quadratic equation with respect to u? It is enough if one of the following questions comes to the reader's mind:

$$2u^2 - 5uv + 2v^2 = 2u^2 - 4uv - uv + 2v^2 = 2u(u-2v) - v(u-2v) = (2u-v)(u-2v) = 0!$$

Hence, equation (A).'

$$(2\sqrt[8]{1+x} - \sqrt[8]{1-x})(\sqrt[8]{1+x} - 2\sqrt[8]{1-x} = 0$$

It is possible to write and solve in the form;
(B) if we divide both sides of the equation by uv:

$$2\frac{u}{v} + 2\frac{v}{u} = 5,$$

This is similar to example 4 $\frac{u}{v} = y$ with substitution comes to the quadratic equation. Hence both sides of equation (A).$\sqrt[8]{(1-x(1+x)}$ dividing by$\frac{\sqrt[8]{1-x}}{\sqrt[8]{1-x}}$ =y a quadratic equation is formed. It is only necessary to ensure that the act of bund is legal: $\sqrt[8]{(1-x(1+x)} = 0$ will it be In this case, either x=1 or x=-1. But it can be seen from the equation (A) that these numbers are not roots.

Not only to be able to perform the algebraic form substitution correctly, but also the current considerations should reach a simple level as an element of mathematical culture.
$ax^4 + bx^3 + cx^2 + bx + a = 0$ tenglamani yeching.

An experienced student says "the equation should be divided by x2" what is this "idea" based on? It is natural to try to group again.

$$a(x^4+1)+bx(x^2+1)+cx^2=0.$$

Is there a closeness in these terms? $x^4+1\ ifoda\ x^2+1$ is close to the square of:$(x^2+1)^2=x^4+2x^2+1, x^2\ esa\ x^2+1\ ning$ "almost himself". So, Eq

$$a[(x^2+1)^2]+bx(x^2+1)+cx^2=0$$

Or

$$a(x^2+1)^2+bx(x^2+1)+(c-2a)x^2=0$$

We can write Now it is not difficult to see that dividing by x^2 is not without benefits:

$$a(\frac{x^2+1}{x})^2+\text{b}\left(\frac{x^2+1}{x}\right)+c-2a=0$$

A quadratic equation (y=$\frac{x^2+1}{x}$ $ga\ nisbatan$).

Only when the roots of bus afar y1,y2 are found, we come back to quadratic equations:

$$\frac{x^2+1}{x}=y_{1,}\quad \frac{x^2+1}{x}=y_{2,}$$

6. $a-\sqrt{a-x}=x^2$. If one simple method is chosen root loss,
7. $x^4-2ax^2-x+a^2-a=0$ (3)

An equation is formed, and there is no simple way to divide it into its multipliers. It is also abstract to introduce the given equation into a familiar form by introducing new information. Even so

$$\sqrt{a+x}=y \qquad (4)$$

it doesn't hurt to see:

$$a-y=x^2$$

If we look at this equation and (G), we notice that they are related.

$\sqrt{a+x}=y \Rightarrow a+y=y^2(y\geq 0\ should\ be\ memorized)$. Thus, instead of the given equation

$$\begin{cases}a+x=y^2\\ a-y=x^2\end{cases} \qquad (5)$$

we have a system.

Bringing the given equation (5) to the system is a very original way, because usually the system is solved by bringing the equation to the system. We are going the opposite way. So (5) How will the system be solved now? One simple method of substitution is useless - algebraic addition. In this case, it is not difficult to see that it is necessary to subtract the second from the first equation of the system (5): both a disappears and a well-known u2-x2 expression appears. So, let's separate$x-(-y)=y^2-x^2$

$$x+y=(y-x)(y+x)$$

We come to Eq. This is another simple calculation:

Let's conclude a little: a) a simple problem is solved by one or two well-known methods, and a complex problem requires a long chain of simple rules and considerations. The longer this "chain" is, the more difficult and complex the problem is: b) the solution to a standard problem is visible as soon as one gets acquainted with the condition of the problem, at least the correct direction of the solution is noticeable, this is not the case in a complex problem. you may encounter unexpected obstacles, dead ends, you may have to go back and choose a new path; 3) solving a simple problem usually does not require much, while a complex problem may require a lot of experience; 4) a complex problem may require a new observation from the student, which has not been used before, compared to a simple problem. For example, in Example 6, dividing this equation by Sistema; 5) There is no "Chinese wall" separating simple and complex issues. solving a simple problem in a complex way, and on the contrary, some complex problems can be "solved" by simple methods, keeping them in the "shall I sit and freeze" tribe. No matter what happens, a student who is enlightened to what he strives for will find the key to another if he does not get stuck in one difficult problem.

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