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Research Article

METHODOLOGY FOR SOLVING EQUATIONS WITH MULTIPLICATIONS OF INTEGER AND FRACTIONAL PARTS IN SCHOOL MATHEMATICS LESSONS

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ABSTRACT

This article describes the ways in which equations involving integers and fractions are given in school mathematics classes and their solution methods.

KEYWORDS

Equations and inequalities involving whole number, fractional part of number, whole number and fractional part of number are covered.

INTRODUCTION

In the plan of measures indicated in the Resolution of the President of the Republic of Uzbekistan dated May 7, 2020 "On measures to increase the quality of education in the field of mathematics and develop scientific research" No. PD-4708 tasks such as organization of research in cooperation with world scientific centers of development, organization of popularization of modern science achievements, strengthening of relations between scientific research activities and the educational process have been defined.

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Today, our community of pedagogues requires urgent tasks such as developing new methods of education, strengthening inter-disciplinary connections (integration), educating young people who can think creatively and independently in every way.

General secondary education is compulsory education consisting of I-XI grades. This type of education covers the primary class (grades I-IV) and provides students with regular knowledge of thinking, academic and general cultural knowledge, spiritual and moral qualities based on universal national values, work forms skills and career choice.

Current textbooks, educational and methodical manuals provide enough information about the equation and its types. Many methods of solving them have been developed. However, the method of solving equations involving whole and fractional numbers in the school mathematics course and explaining them to students is not sufficiently developed. That's why we set ourselves the goal of "developing a methodology for solving various equations involving whole and fractional parts and explaining them to students"[5].

To achieve this goal, it is necessary to perform the following tasks:

to determine the current methodical conditions of solving equations involving the whole and fractional part of the number among students of the school;

to determine the content and structure of the equations in which the whole and fractional parts of the number are involved;

use and improve the methods of experienced advanced pedagogues for solving equations involving whole and fractional numbers in educational materials for teaching mathematics in schools;

to determine the content and structure of the equations in which the whole and fractional parts of the number are involved;

show the method of solving equations involving the whole and fractional part of the number in the secondary school.

We are trying to improve the scientific methodical solution of equations of different forms (rational and transcendental) involving whole and fractional numbers, based on the purpose, content, form, method and tools of mathematical education:

we determine the structure and content of the educational material for school students to form the methodology of solving equations involving whole and fractional numbers;

we improve students' methods of solving rational equations involving whole and fractional numbers.

If we look at the history of mathematics, the famous Greek mathematician Euclid in his work "Fundamentals" explained algebraic expressions and the operations between them by intersections, that is, he used geometric algebra.

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Russian mathematicians I.F. Sharigin, N.B. Alfutova, G.Z. Genkin, V.L. Kryukova, Ukrainian mathematician I.A. Kushnir, Tajik mathematician A. Sufiyev conducted research on the solutions of problems involving whole and fractional numbers.

Before we teach students about equations involving whole and fractional numbers, we should give them information about the equation and its solution.

The concept of an equation is presented in a school mathematics course, and students learn to find the unknown component when two of the components involved in addition, subtraction, and division are known.

An equation with an unknown number is called an equation. The value of the unknown that makes the equation a true equation is called the solution or root of the equation.

We have studied the equations in which whole and fractional parts of the number are involved, divided into several groups [2,3,4].

1. *Equations of the form* $[\boldsymbol{f}(\boldsymbol{x})] = \boldsymbol{a}$ ***and*** $\{\boldsymbol{g}(\boldsymbol{x})\} = \boldsymbol{b}$.

From the equation $[f(x)] = a,\ \ a \in Z$ we form the relation $a \le f(x) < a+1$, then $[f(x)] = f(x) - \{f(x)\}$ and put into the given equation:

$$f(x) - \{f(x)\} = a \ \rightarrow \{f(x)\} = f(x) - a$$

Since $0 \le \{f(x)\} < 1,\ 0 \le f(x) - a < 1.$

Example 1. We solve the equation $[x^2 + 2x - 2] = 1$

The solution. We reduce this equation to a double inequality based on the above.

$$1 \le x^2 + 2x - 2 < 2$$

1) $x^2 + 2x - 2 \ge 1 \rightarrow x^2 + 2x - 3 \ge 0 \rightarrow$

$\rightarrow (x+3)(x-1) \ge 0 \rightarrow x \le -3; x \ge 1$

2) $x^2 + 2x - 2 < 2 \ \rightarrow x^2 + 2x - 4 < 0 \ \rightarrow$

$\rightarrow -1-\sqrt{5} < x < -1+\sqrt{5}$

$$-1-\sqrt{5} < x \le -3; \cup\ 1 \le x < -1+\sqrt{5}$$

Answer. $-1-\sqrt{5} < x \le -3; \cup\ 1 \le x < -1+\sqrt{5}$

Example 2. We solve the equation $\{cosx\} = \frac{1}{3},\ \ x \in [0\,;\pi]$

The solution. In this equation $cosx = \frac{1}{3} + n$, $-1 \le \frac{1}{3} + n \le 1,\ \ n \in Z,$

is divided into two simple trigonometric equations n=0 and n=*-1* (n has no meaning for other values of the trigonometric equation).

$$cosx = \frac{1}{3} \ \text{and}\ cosx = -\frac{2}{3},\ x \in [0\,;\pi]$$

$$x = arccos\frac{1}{3} \ \text{and}\ x = \pi - arccos\frac{2}{3}$$

Answer. $arccos\frac{1}{3},\ \pi - arccos\frac{2}{3}$.

2. Equations of the type $\boldsymbol{k}[\boldsymbol{x}] = \boldsymbol{x}$ **and** $\boldsymbol{k}\{\boldsymbol{x}\} = \boldsymbol{x}$

To solve equations of this type, first consider it for the number $k \in R/0$

Let's consider solving the equations $k[x] = x$ and $k\{x\} = x$

This process is carried out based on the following algorithm [1,2].

1) Since $[x] = \frac{x}{k}$from the equation $k[x] = x,\ \ \frac{x}{k} \in Z$,, that is, $x = kn,\ \ n \in Z$

2) Since $x - \{x\} = \frac{x}{k}$ or $\{x\} = x\left(1 - \frac{1}{k}\right),\ \ \ 0 \le x(1 - \frac{1}{k}) < 1.$

So this is a solution to the equation

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$$\begin{cases} x = 5n, \ \ n \in Z \\ 0 \le x(1 - \frac{1}{k}) < 1 \end{cases}$$

determined from relationships.

Example 3. We solve the equation $3[x] = x$

The solution. Since $k = 3$

$$\begin{cases} x = 3n, \ \ n \in Z \\ 0 \le x(1 - \frac{1}{3}) < 1 \end{cases}$$

relationship is enough. Since $0 \le x < \frac{3}{2}$is equal to $0 \le 3n < \frac{3}{2} \ \ \rightarrow \ \ 0 \le n < \frac{1}{2}$ and $n = 0$ is the unique integer solution $x = 0$.

Since $k\{x\} = x$ from the equation $\{x\} = \frac{x}{k} \in [0,1)$

$$x \in [0, k) \ agar \ k > 0 \ bo'lsa$$
$$x \in (k, 0], agar \ k < 0 \ bo'lsa$$

we form relationships.

Since $\{x\} = x - [x]$ the equation under consideration

$$k(x - [x]) = x \quad \rightarrow \quad [x] = \left(1 - \frac{1}{k}\right)x$$

if we take $[x] = n$ since $[x] \in Z$ to the equation,

$$\frac{k-1}{k}x = n; \ \ x = \frac{nk}{k-1}$$

will be.

But taking into account that $x \in [0, k)$, $k > 0$ and $x \in (k, 0], k < 0$, let n be $0 \le \frac{nk}{k-1} < k$, if agar $k > 0$ and va $k < \frac{nk}{k-1} \le 0$ if $k < 0$, we can define relations and find the desired solution or set of solutions.

Example 4. We solve the equation $3\{x\} = x$

The solution. Since $k = 3 > 0$, the solution of the equation is in the form $x = \frac{nk}{k-1} = \frac{3n}{2}$, and the inequality $0 \le \frac{3n}{2} < 3$ must be satisfied. Since $0 \le n < 2$ the corresponding roots of the unknown x consist of $\left(0\,;\,\frac{3}{2}\right)$ numbers.

3. Equations of the form $[f(x)] = g(x)$.

When solving equations of this form, we use the definition of the integral part of the number, taking into account that the expression on the left side of the equation is a whole number and the right part is also a whole number [20].

$[f(x)] = g(x)$ from which $g(x) \le f(x) < g(x) + 1$. If we solve this double inequality, we get the result.

Example 5. We solve the equation $[3x + 4] = 4x + 5$.

The solution. Solving this equation using the property $[x + a] = [x] + a, \ \ x \in R, \ \ a \in Z$

$$[3x] + 4 = 4x + 5 \ \rightarrow \ [3x] = 4x + 1$$

we form the equation.

We write this equation in the form of a double inequality as follows:

$$4x + 1 \le 3x < 4x + 2$$

we have this system of inequalities:

$$\begin{cases} 4x + 1 \le 3x \\ 4x + 2 > 3x \end{cases} \rightarrow \begin{cases} x \le -1 \\ x > -2 \end{cases}$$

An integer satisfying this system of inequalities is -1.

Example 6. We solve the equation $\frac{x}{x+4} = \frac{5[x]-7}{7[x]-5}$

The solution. To solve this equation, we first introduce the notation $[x] = n, \ \ n \in Z$:

$$\frac{x}{x+4} = \frac{5n-7}{7n-5}$$

we find x from this equation:

$$7xn - 5x = 5nx - 7x + 20n - 28$$

$$x = \frac{10n - 14}{n + 1}$$

Since the inequality $n \leq x < n + 1$holds using the integer property $[x] = n$

$$n \leq \frac{10n - 14}{n + 1} < n + 1$$

we get this double inequality.

The solution of this inequality is $n = 2, 6, 7$. Now we find the value of x. remains equal to $x = \left(2 \; ; \; \frac{46}{7} \; ; \; 7\right)$.

4. Equations involving whole and fractional parts.

If we are given an equation that contains a whole and a fractional part in one equation, it is much more convenient to convert the whole part into a fractional part or convert the fractional part into a whole part in order to solve it.

Example 7. We solve the equation $2^x = 3^{[x]} \cdot 4^{\{x\}}$

The solution. We logarithmize this equation according to two bases:

$$x = [x]log_2 3 + 2\{x\} \to \begin{cases} [x] = n, \; n \in Z \\ n \leq x < n + 1 \\ x = nlog_2 3 + 2(x - n) \end{cases}$$

let's simplify

$$\begin{cases} n \leq x < n + 1 \\ x = 2n - nlog_2 3 \end{cases}$$

$$n \leq 2n - nlog_2 3 < n + 1$$

$$0 \leq n - nlog_2 3 < 1$$

$$0 \leq n(1 - log_2 3) < 1$$

$$\frac{1}{1 - log_2 3} < n \leq 0$$

The solution of this double inequality is $n_1 = -1, \; n_2 = 0$. If we take these values, the result will be natija $x = log_2 3 - 2$ and $x = 0$.

Example 8. We solve the equation $[x] + [3x] + [5x] = 4$.

The solution. This equation has no solution at $x < 0, \; x > 1$

We consider the following cases:

1) $[x] = 0 \;\; 0 \leq x < 1, \; [3x] = 2 \; \frac{2}{3} \leq x < 1, \; [5x] = 2 \; \frac{2}{5} \leq x < \frac{3}{5}$ intersect $\frac{2}{5} \leq x < \frac{3}{5}, \;\; [x] = 0 \;\; [3x] = 1 \;\; [5x] = 2 \;\; 0 + 1 + 2 = 3 \neq 4 \;\; \emptyset$,

2) $[x] = 0 \;\; 0 \leq x < 1, \; [3x] = 1 \; \frac{1}{3} \leq x < \frac{2}{3}, \; [5x] = 3 \; \frac{3}{5} \leq x < \frac{4}{5}$intersect $\frac{3}{5} \leq x < \frac{4}{5}$, 3) $[x] = 0, \; [3x] = 1 \;\; [5x] = 3 \;\; 0+1+3=4$.

Answer$\frac{3}{5} \leq x < \frac{4}{5}$.

Example 8. We solve the equation $[sinx]\{sinx\} = sinx$.

The solution. $[x] + \{x\} = x$, $[sinx](sinx - [sinx]) = sinx$

1) $-1 < sinx < 0, \;\; [sinx] = -1 \;\;\;\; sinx = \frac{1}{2} \;\; x = \pm\frac{\pi}{6} + \pi n$.

2) $0 < sinx < 1, \;\; [sinx] = 0 \;\;\;\; sinx = 0 \;\;\; x = \pi n$, 3) $sinx - 1 = sinx \;\; \emptyset$.

One of the indicators of an effectively organized educational process is the development of students' mathematical abilities. The student's research activity is manifested in the ability to find solutions that differ from standard and generally accepted solutions, and to apply his knowledge to various conditions in performing actions. In order to develop these qualities,

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providing students with dynamic exercises and tasks that require research knowledge will greatly help to stimulate student behavior.

In the teaching of mathematics, students' ability to solve equations is studied based on the basic laws, rules, and methodological conditions of the knowledge system. In this, the issues of creating a system of mathematical knowledge and its implementation, in-depth study of the laws and rules of mathematics, and cases of thorough mastering are determined.

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