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METHODOLOGY FOR TEACHING THE THEORY OF REAL NUMBERS IN GENERAL SECONDARY SCHOOLS AND ACADEMIC LYCEUMS

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ANNOTATION
In this article we want to express an opinion about the methods of teaching the theory of real numbers in general secondary education and academic lyceums, which of these methods are more acceptable to teach.

Signal words: rational numbers, irrational numbers, twin prime numbers, Eratosthenes grain, periodic fractions, interval, half-interval, incision, open beam, arithmetic square root, rational numbers, Catalan variation, Euler's variation, Euclidean theorem.

Introduction

As you know, rational and irrational numbers together form a set of real numbers. For each real number, the coordinate corresponds to the single point of a straight line. The set of real numbers is also known as the number straight line. The geometric model of a number straight line consists of a coordinate straight line.

After the teacher shows a geometric image of real numbers, it is advisable to compare real numbers through the question and answer method and describe the numerical inequality that will be formed as a result of them, as well as their properties. The question of comparing real numbers is based on the following two definitions will be solved.

Description. if the subtraction is positive when subtracting the number b from the number a, Without the number a is called greater than the number b, and it is written as follows: a-b>0, from this it seems that a>b.

Description. if the subtraction is negative when subtracting the number b from the number a, Without the number a is called smaller than the number b, and I is written like this: a-b<0, from which it seems that a<b. Expressions A >b and a<b here are called numerical inequalities.

Properties of numerical inequalities:

1) if a > b, b<a will be;
2) if a > b and b<c, then a<c will be;
3) if a>b, a+c > b+c will be;
4) if a>b and S are positive numbers, then ac>bc

Proof: we form ac-bc subtraction. ac-bc=c (a-b) according to the condition
since c is a positive number and a>b, a-b is a positive number. Two positive
the product of a number is a positive number, which means c(a—b)>0. So that, ac-bc>0, from this: ac > bc;

5) if a>b and c are a negative number, then the ac will ac<bc. If
if both sides of the inequality are multiplied by the same negative number,
the gesture of inequality changes to the opposite;

6) if a>b and c>d, then a+c>b + d will be;

7) if a>b>0, then it will $\frac{1}{a} < \frac{1}{b}$;

8) if a>b>0, the inequality for any n natural number $a^n > b^n$ it will be appropriate.

Numerical intervals and their image

Type of intervals	Setting	Writing using inequalities
Interval	$(a; b)$	$a < x < b$
Incision	$[a; b]$	$a \leq x \leq b$
Half interval	$(a; b]$	$a < x \leq b$
Half interval	$[a; b)$	$a \leq x < b$
Nur	$[a; +\infty)$	$x \geq a$
Nur	$(-\infty; b]$	$x \leq b$
Open nur	$(a; +\infty)$	$x > a$
Open nur	$(-\infty; b)$	$x < b$

The modulus of a real number and its properties. The real number is the modulus of a, if a>0, it is said to the number itself, and if a<0, it is said to the opposite number. A is defined as the modulus of a number |a|.

So that,

$$|a| = \begin{cases} if\ a > 0\ , a \\ if\ a < 0\ , -a \end{cases}$$

For example, $|x - 3| = x - 3$, because

$$\begin{cases} \boldsymbol{x - 3 > 0, x > 3,} \\ \boldsymbol{x - 3 < 0, x < 3.} \end{cases}$$

From a geometric point, the expression indicates the distance from point a to Point 0 on the coordinate straight line.

Properties of modules:

$|a| \geq 0.$

$|a| = |-a|.$

$|ab| = |a| \cdot |b|.$

$\left|\frac{a}{b}\right| = \frac{|a|}{|b|}, b \neq 0.$

$|a|^2 = a^2.$

Rules for performing actions on real numbers

The sum of two numbers with the same sign is equal to the sum of the same sign. To find the module of such a sum, it is necessary to find the sum of the joins.

For example, (+12)+(+8)=+20, (-12)+(-8)=-20.

The sum of two numbers with different signs is the same sign number as the sign of the suffix with a large one, in order to find the value of this sum, it is necessary to subtract a small number from the large one and put a large sign in front of the subtraction.

For example: (12)+(-8)=+(12-8)=4, (-12)+(+8)=-(12-8)=-4.

To subtract the second from one number, it is necessary to add to the diminutive the number opposite to the subtractor.

For example, 12-(-8)=12+8=20, 12-(+8)=12-8=4.

The product (division) of two numbers with the same sign is a positive number, the product of two numbers with different signs is a negative number, and the division is also a negative number. To find the multiplication (division), you need to multiply (divide) among the given numbers.

For example, (-12)˙(-8)=+12˙8=96, (-24):(+3)=-24:3=-8.

Properties of arithmetic operations.

$\boldsymbol{a+b=b+a}$;

$\boldsymbol{(a+b)+c=a+(b+c)}$;

$\boldsymbol{a+0=a}$;

$\boldsymbol{a+(-a)=0}$;

$\boldsymbol{ab=ba}$;

$\boldsymbol{(ab)c=a(bc)}$;

$\boldsymbol{a(b+c)=ab+ac}$;

$\boldsymbol{a\cdot 1=a}$;

$\boldsymbol{a\cdot\frac{1}{a}=1, a\neq 0}$.

Introduction of the concept of rifmetic square root

In the course of algebra of the VII class, the concept of" arithmetic square root " is introduced.

If $x^2 = 16$ readers of this equation if the equation is given multipliers know how to solve by dividing, that is

$x^2 = 16 \rightarrow x^2 - 16 = (x-4)(x+4) = 0 \rightarrow x_1 = 4, x_2 = -4.$

(Say, $x^2 = 16$ solutions to the equation $x_1 = 4, x_2 = -4$ from the numbers as long as it consists. To deduce the following rule according to the above considerations can: $x^2 = 16$ the roots of the equation, that is, the square of which is equal to 16.

$x_1 = 4, x_2 = -4$ the numbers are called the Square Roots of the number 16.

$(-4)^2 = 16$, $4^2 = 16$

since the numbers -4 and 4 $x^2 = 16$ are the square roots of the equation.

Description. the square root of the number a is that Square a is equal to the number the number is said.

Beyond the concept of square root, the arithmetic concept of square root as well, it can be explained as follows: $x_1 = 4, x_2 = -4$,

$x^2 = 16$ there are two roots in the equation, of which $x_1 = 4$ the solution is positive. Such a positive or non-trivial solution is the arithmetic square of that equation it is called. This concept, in general, is defined as follows.

Description. the arithmetic square root of the number a is said to be an unnamed number whose Square is equal to a, and it is $\sqrt{a}$ is defined as.

Rational numbers.

In mathematics, when performing some action, the numbers known until then remain insufficient. For example, to find the subtraction of two natural numbers, the integer
there is a need to introduce the concept of numbers, the concept of rational numbers to be a natural number. In this regard, the set of natural numbers $N = \{1,2,3, \dots, n, \dots\}$ set of integers $Z = \{\dots - 3, -2, -1, 0, 1, 2, 3, \dots\}$ will be expanded up to. And this set of rational numbers up to the set Q will be expanded. Rational numbers $\frac{m}{n}$ is written in the form of m, in which m is an integer, N is a natural number. For example: $\frac{3}{5}; \frac{-4}{7}; \frac{4}{9}; \frac{16}{25}$.

Four arithmetic operations on rational numbers (in addition to dividing by zero) when done, a rational number is always formed.

A rational number can be written in the form of a finite or infinite decimal fraction.

For example, numbers can be written in decimal form with a finite: $\frac{3}{5}$ *and* $\frac{5}{8}$

numbers can be written in decimal form with a finite: $\frac{3}{5} = 0{,}6; \frac{5}{8} = 0{,}625;$

$\frac{2}{3}; \frac{2}{9}; \frac{7}{11}$ the result of dividing the image of fractions by the denominator by the column method is an infinite decimal can be written in decimal form: $\frac{2}{3} = 0{,}666 \dots; \frac{2}{9} = 0{,}222 \dots; \frac{7}{11} = 0{,}6363 \dots$

What rational fractions can be written in the form of a finite Decimal Fraction
the following theorem answers the question:

Theorem: Contraction $\frac{a}{b}$ for a rational fraction to be written in decimal form with a finite fraction denominator 2 and 5 it is necessary and sufficient that it does not have fundamentally different divisors from. Number b in this, of course, $2^k \cdot 5^n$ shaklida bo'lishi shart emas, this 2^k or 5^n can also be in shape.

Examples:

$$\frac{3}{10} = \frac{3}{2 \cdot 5} = 0{,}3; \ \frac{1}{5} = 0{,}2; \ \frac{5}{8} = \frac{5}{2^3} = 0{,}625; \ \frac{34}{80} = \frac{17}{40} = \frac{17}{2^3 \cdot 5} = 0{,}425.$$

0,666... in the infinite decimal notation, the number 6 is repeated, 0.636363... unlimited in decimal notation, however, two groups of numbers of 63 are repeated. First the number 6, which is repeated in the example, the number 63 in the second example, respectively the fraction period is called, and the fraction itself is called the periodic fraction. In the first case it is written as 0,(6), in the second case

0,(63). Read also:” zero in the whole ten to 6 period“,”zero in the whole hundred to 63 period". It is correct to read 0,0(6)as “zero in 6 periods from the whole hundred.”
If it is said that” Zero is in the entire 6 period", then there is no difference between' 0, (6) and 0,0(6) remains.
Issue 1. This 1) 1,(6); 2) 0,3(79) an infinite periodic Decimal Fraction is simple describe in decimal form.
1) 1,(6) = 1,666... we mark the value as x. In it 10x= 16,(6) = 16,666... We perform the following subtraction: $10x - x = 16,(6) - 1,(6) = 15; 9x = 15.$
From this, $x = \frac{15}{9} = 1\frac{6}{9} = 1\frac{2}{3}.$
2) 0,3(79) we mark the value as x: 0,379=x. Two sides 1000 we multiply by:
1000x=379,(79). We perform subtraction: 1000x-10x=379,(79)-3,(79)=376.
990x=376, $x = \frac{376}{990} = \frac{188}{495}$ from this is formed. Say, 0,3(79)= $\frac{188}{495}.$
Transition from a periodic decimal to a simple fraction with the method used in Issue 1 the formula can also be deduced.
Examples:

$$1,(6) = 1 + 0,(6) = 1 + \frac{6}{9} = 1\frac{2}{3} = \frac{5}{3};$$

$$0{,}3(79) = \frac{379-3}{990} = \frac{376}{990} = \frac{188}{495};$$

$$2{,}35(3) = 2 + \frac{353-35}{900} = 2 + \frac{318}{900} = 2 + \frac{53}{150} = \frac{353}{150};$$

$$0{,}19(34) = \frac{1934-19}{9900} = \frac{1915}{9900} = \frac{383}{1980}.$$

Thus, all natural numbers, all integers and all simple fractional numbers are rational numbers. Other than Infinite periodic fractions in mathematics infinite non-periodic numbers are also seen. For example, 0,1234... number unlimited Decimal Fraction, but not periodic fraction. Also 0,1010010001... in the fraction every 1 the number of zeros after the number is increasing by one. This is not a periodic Decimal Fraction.
Non-periodic infinite decimal fractions are called irrational numbers. Rational and irrational number make up the set of real number.
Arithmetic operations and comparison rules on real numbers, equality and the properties of inequalities are the same as those of rational numbers.
Irrational numbers can be formed during the square root extraction process. If the number below the square root is not the square of a number, then the square the root value will be an irrational number. Including, $\sqrt{1{,}21} = 1{,}1^2,$ say, $\sqrt{1{,}21}$ - ratsional number; but $\sqrt{1{,}25}$ number is an irrational number because the square 1,25 to there is no rational number that is equal. Say, $\sqrt{1{,}25}$ - irratsional number.
Irrational numbers. Real numbers
Irrational numbers do not appear only as a result of square root extraction.

For example, we know that the ratio of the length of a circle to its diameter does not change. It is defined as π. This is the irrational number π : $\pi = 3{,}141592\ldots$

Currently, π millions of numbers after the comma are calculated. There are a number of invariants that come from different species. Including,

e =2,718281..., c = 0,577215... (Euler variation), G = 0,915965... (Catalan variation) numbers are irrational numbers.

Methodology for teaching the theory of real numbers in academic lyceums.

In academic lyceums, the introduction to the theory of real numbers first teaches prime numbers, complex numbers, twin prime numbers, natural numbers and their properties. After that, the concept of an irrational number, arithmetic operations on real numbers are introduced.

Prime and complex numbers. The numbers used to count things are called natural numbers. The infinite set formed by all natural numbers is denoted by the letter N: N = {1, 2, ..., n, ...}. The set of Natural numbers does not contain the largest number (element), but a natural number greater than 1, which has no other natural divisor than the smallest 1 and itself, is called a prime number. For example, 2, 3, 5, 7, 11, 13, 17, 19 numbers are all prime numbers smaller than 20.

A natural number greater than 1 with a natural divisor other than 1 and itself is called a complex number. For example, 4, 6, 8, 9, 10,12, 14, 15, 16, 18 numbers are all complex numbers smaller than 20.

From definitions given to Prime and complex numbers, it turns out that 1 is neither a prime nor a complex number. A natural number with such a property is only 1 itself.

We look at some properties of Natural numbers:

1-property. Any p > 1 the smallest of the divisors of the natural number not equal to 1 will be the prime number.

Proof . p > let the smallest divisor of a natural number not equal to 1 be Q. Suppose it is a complex number. Then, according to the definition of a complex number, the number q is a number.$1 < q_1 < q$ to the condition

subordinate q_1 will have a divisor and q_1 number will also be the divisor of p. And it is impossible to be such. So, q-prime number.

2nd property: the smallest divisor of a complex number p greater than 1 is a prime number not greater than $\sqrt{p}$

Proof:. p is a complex number, and q be its smallest divisor different from 1. Without it

$p = q \cdot q_1$ (in this division q_1) and $q_1 \geq q$ there will be a natural number that will be q_1 .. From this relationship $p = q \cdot q_1 \geq q \cdot q$ or $\sqrt{p} \geq q$ we get the. By property 1, the number q is a prime number.

3-property: (Euclidean theorem). The prime numbers are infinite.

Isbot . All prime numbers are n and they are $q_1, q_2, \cdots, q_n$ suppose it consists of numbers. The number without it $b = q_1 \cdot q_2 \cdot \ldots \cdot q_n + 1$ because the number will be a complex number $q_1, q_2, \cdots, q_n$ there is no prime number other than numbers (according to hypothesis). let q be the smallest divisor of b not equal to 1. By property 1, q is a prime number and $q_1, q_2, \cdots, q_n$ consists of any of the numbers. b and $q_1 \cdot q_2 \cdot \dots \cdot q_n$ since each of the numbers is divided by q, the number 1 is also divided by q. From this, q = 1 it comes from the fact that it is. This is contrary $q \neq 1$ to the fact that. Our hypothesis is wrong. Hence, the prime numbers are infinitely many.

When constructing a table of prime numbers that are no larger than one n number, they use a simple method called the Eratosthenes grain. We will get acquainted with its essence.

This: 1, 2, 3, ..., n (1)

take the numbers.

(1) the first number greater than 1 is 2; it is divided only by 1 and by itself, which means that 2 is a prime number. (1) leaving 2, we erase all the complex numbers that are its Carral; the non-deleted number that stands after 2 is 3; it is not divided by 2, which means it is only divided by 1 and by itself, so it is a prime number. (1) also 3 ni
leaving, we erase all the numbers that are multiples of it; from 3
then the first number that does not turn off the riser is 5; it is neither 2 nor 3
divided. So 5 is divided only by 1 and by itself, so it will be a prime number, and so on.k.

If p is a prime number and all numbers divisible by prime numbers smaller than p are deleted by the above method,p^2 all undelete numbers smaller than the prime number will be.

Indeed, in this p^2 every complex, small from a number, is erased because it is a Carral of its smallest subset.

So that:

the deletion of numbers that are divisible by prime number p should start from p^2 ;

the construction of a table of prime numbers not greater than n is completed after deleting the divisors of prime numbers not greater than $\sqrt{n}$.

Example 1: Find the smallest subset of the number 827.

Solution . Prime numbers smaller than 827 2, 3, 5, 7, 11, 13, 17, 19, 23 having determined that it is, we divide 827 into these numbers. 827 it is not divided by any of the numbers, from which it follows that 827 is a prime number.

Example 2: determine the prime numbers located between the numbers 15 and 50.

Solution: 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 taking the numbers, we draw under the numbers 2, 3, 5.7 times. 17, 19, 23, 29, 31, 37,41, 47 the numbers are the sought-after prime numbers.

In the line of Natural numbers, prime numbers are distributed differently. Sometimes adjacent prime numbers differ from each other by 2 g, for example, 11 and 13, 101 and 103, etc. These numbers are called twin prime numbers. The finite or infinity of the set of twin prime numbers is still unknown.

With the help of counting machines, very large prime numbers were found. For example, $2^{86243} - 1$ is prime number.

Much information about prime numbers has been verified for very large numbers, but has not been proven. For example, we do not know whether it is possible to write any even number in the form of a subtraction of two prime numbers (for example, 14 =127 -113, 20=907-887, etc.). There are also assumptions that for any even number, such representations will be infinite.

As we know, in pedagogy, the following requirements are paid attention to setting up a topic for a student: what you want to teach, who you want to teach and in what way you want to teach.

Taking these requirements into account, we preferred to explain the teaching of the theory of real numbers in secondary schools and academic lyceums through more practical examples, introducing in stages natural numbers, integers, rational numbers, irrational numbers and their properties. Because through such a methodology, the properties of the set are introduced into relatively simpler more convenient methods, and especially the actions on real numbers, and their properties in a convenient, understandable way for readers.

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