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DESIGN AND RESEARCH ACTIVITY OF STUDENTS AS A PEDAGOGICAL PROBLEM

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ABSTRACT

This article presents the pedagogical foundations of students' design-research activity. A system of tools for forming students' design-research activity has been developed. Four types of students' design-research work and the mechanisms of their formation are discussed. The content of project work in teaching the elements of the theory of series and the peculiarities of the execution of these tasks are shown. The content of imitation, renewal, search-implementation and creative project work is presented. The methods of improving the design-research activities of students of future mathematics majors, the features of project work organization are described. The important stages of the teacher's preparation of project work and the students' performance Given. We consider the design activity of students and the project method as a form of organization of students' project activity in an inextricable connection. With the design method, teaching high school mathematics courses and the meaning of students' project activity, its role, significance and place in the educational process are met with different views.

Keywords: Design, Tools, Model, Technology, Arithmetic

PEDAGOJİK BİR PROBLEM OLARAK ÖĞRENCİLERİN TASARIM VE ARAŞTIRMA FAALİYETLERİ

ÖZET

Bu makale, öğrencilerin tasarım-araştırma etkinliklerinin pedagojik temellerini sunmaktadır. Öğrencilerin tasarım-araştırma aktivitelerini oluşturmak için bir araç sistemi geliştirilmiştir. Dört tür öğrenci tasarım-araştırma çalışması ve bunların oluşum mekanizmaları tartışılır. Seri teorisinin unsurlarının öğretilmesinde proje çalışmasının içeriği ve bu görevlerin yerine getirilmesinin özellikleri gösterilmektedir. Taklit, yenileme, arama-uygulama ve yaratıcı proje çalışmalarının içeriği sunulur. Geleceğin matematik bölümlerindeki öğrencilerin tasarım-araştırma faaliyetlerini geliştirme yöntemleri, proje çalışması organizasyonunun özellikleri açıklanmaktadır. Öğretmenin proje çalışmasını hazırlamasındaki önemli aşamalar ve öğrencilerin performansları verilir. Öğrencilerin tasarım faaliyetini ve proje yöntemini, öğrencilerin proje faaliyetinin ayrılmaz bir bağlantı içinde bir organizasyon biçimi olarak görüyoruz. Tasarım yöntemi ile lise matematik derslerinin öğretimi ve öğrencilerin proje etkinliğinin anlamı, eğitim sürecindeki rolü, önemi ve yeri farklı görüşlerle karşılanmaktadır.

Anahtar Kelimeler: Tasarım, Araçlar, Model, Teknoloji, Aritmetik

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RESEARCH HISTORY

The origins of the design and research activities of students have deep roots that go back to the distant past. Even in ancient times, it was known that cognitive activity contributes to better memorization and deeper insight into the essence of objects, processes and phenomena.

In the natural scientific works of medieval thinkers of the Near and Middle East, there is a serious interest in various aspects of scientific knowledge, its principles, structure, criteria, and the connection of scientific knowledge with the mental development and education of a person.

A characteristic feature of the epistemological views of Khorezmi, Kindi, Farabi, Beruni, Ibn Sina, Omar Khayyam and Tusi, their associates and followers is that their attention was constantly attracted by the process of abstracting the image of an object in the mind of a person, as a result of which the concept of essence and the specifics of this subject.

What are the subject and sources of cognition, what are the stages of the process of cognition, what are the relations between cognitive and design and research activities, a far from complete list of cognition issues that attracted almost all prominent thinkers of the medieval East. Khorezmi [1] clearly distinguished cognition through “sensation” from cognition through “logical reasoning”: the former cognizes the particular: “small”, and “logical” studies the essential, significant, but they are interconnected. The germs of the theory of knowledge arose with the advent of science itself and are continuously developing. Khorezmi made a significant contribution to the development of this theory. He was one of the first to scientifically substantiate the experimental-observational and experimental method of cognition in the form of a tabular reflection of the movement of celestial objects, as well as spatial arrangements, ground points, concretized the principle of unity of the individual, the special and the general in the aspect of induction and deduction: he moved from a particular case in the equation to special (6 equations), but did not reach the general (canonical) form, developed an algorithmic method for solving mathematical problems, which in our time is generally recognized in the general scientific method of cognition and action.

Human knowledge, according to Kindi, is divided into sensual and rational. The object of sensible cognition does not have stability, and although its nature is hidden from us, it is nevertheless very close to the sensuously perceived and always has matter, for it is always a body and is in the body.

Thus, sensory cognition is conditioned by the object itself, its object is everything bodily and material. If sensory cognition is a singular cognition, then rational cognition is general, "Individual material things are susceptible to sensory perception," Kindy wrote, "as for genera and species, they are not susceptible to sensory perception and cannot serve as the subject of sensory cognition. But they are susceptible to the perception of that of the forces of the perfect, that is, the human soul, which is called the human mind. [2, p.62]. According to Kindi, sensory knowledge provides only material for the mind. At the same time, the knowledge obtained through sensory perception, Kindi subordinated the provisions in relation to rational knowledge. He believed that the mind knows what is abstract. Groups of scientists and philologists who founded in the second half of the X century.

School "Brothers of Purity", greatly contributed to the dissemination of natural scientific and philosophical knowledge among the general population of the Arab Caliphate. Questions about labor and design and research activities, about the degree of dignity of crafts, about the work of the mind were considered in the so-called “Messages” of the members of this group: “Know that the activity characteristic of the human race is of two types: cognitive and labor. We affirm that labor activity is the extraction of the form leading man, which is in his thought, and its application to matter. Then they say that “knowledge is the images of the known in the soul of the knower. Know that there is no knowledge without learning and mastering science. And learning is an impulse that comes from the soul that knows actually, to the soul that knows potentially. The assimilation of knowledge is the perception by the soul of the forms of the knowable. Know that the soul perceives the forms of cognizable objects in three ways: firstly, through feelings, secondly, through arguments, thirdly, through reflection and contemplation” [3, p.60].

Farabi attached great importance to the sciences as a necessary means of acquiring and accumulating knowledge, and considered mastering them as an indicator of education. He believed that the sense organs, heart and brain were given to a person from birth, and all the rest - knowledge, various kinds of intellectual and moral properties: character traits, education, etc. - are acquired in the process of human life. Defining various character traits and moral virtues - courage, courage, friendliness, generosity, wit, truthfulness, etc., he considered them the result of education and self-education of the individual. So, according to Farabi, the education of intellectual and moral qualities can be carried out in two ways (methods): the process of voluntary actions of the individual aimed at improvement and under coercion by force. In the works of Farabi, issues of didactics, theoretical problems of teaching, philosophical, physiological and psychological foundations for acquiring knowledge are widely presented. For him, the interaction of object and subject, external being with its variety of forms of existence and the human personality with its complex physiological and mental processes and a rich spiritual world is beyond doubt. So, for example, he believed that the highest stage of human spirituality is the soul, mind and thinking, which are a specific form of human cognitive activity. Farabi developed a number of detailed recommendations on the organization of cognitive and design and research activities. “In order to be a good theorist,” he said, “regardless of the science to which it refers, three conditions must be observed: 1) to know well all the principles underlying this science; 2) be able to draw the necessary conclusions from these principles and data related to this particular spider, i.e. master the rules of reasoning; 3) be able to refute erroneous theories and analyze the opinions of other authors in order to distinguish truth from lies and correct errors.

In the scientific heritage of Beruni, a sore spot is occupied by the scientific method he developed for studying and understanding nature. The characteristic features of the basis of the scientific method of Beruni were the objectivity and impartiality of the scientist, observation, experiments, the study of oral and written monuments, a critical approach to facts, comparing them in order to establish the truth, logical generalization in the form of inferences, transformation of inferences into theory.

Ibn Sina (Avicenna) (X-XI centuries AD) gave a three-dimensional picture of various types of cognitive and design-research activities, presenting them as various forces of the Soul and removing a significant part of these from the power of the divine principle. He identifies three types of soul in accordance with the ancient tradition: plant, animal and rational. In the first, two forces are distinguished, motive and receptive; perceiving, in turn, is divided into perceiving from outside and from within. The first includes five or eight senses. The scientific heritage of Ibn Sina is huge and covers all areas of human knowledge. The essence of these didactic principles is as follows: learning should go from easy to complex. It should be carried out taking into account the inclinations and abilities of children, the exercises should be feasible, and training should be combined with physical exercises. An important pedagogical principle of Ibn Sina is his idea that the human mind is capable of influencing the course of life, because a person differs from an animal precisely in the presence of a mind, and therefore in the ability to realize the act he performs. An important premise in the pedagogical views of Ibn Sina is the idea that the environment plays a leading role in the child's cognition.

For the convenience of subsequent analysis from a modern point of view, we divided the means of design and research activities used in higher education into three groups:

In the first, we include a means aimed at developing the student's personality and his cognitive (and design and research) activities, in the second - mobilizing the existing cognitive forces of the student, in the third - means that contribute to the activation of cognitive and design and research activities.

The means of forming the design and research activities of the first group, as was said by the thinkers of the East, Khorezmi, Kindi and others, are aimed at achieving two main goals: the development of design and research activities and the formation of students' personalities.

Since the development of the personality of students is carried out in the process of the formation of his cognitive activity, these two sides should not be strictly distinguished, but such differentiation, in our opinion, allows a more purposeful approach to solving the problem of improving the project-research activity.

Design - research activity, like any other, has a motivational and operational side (internal and external forces according to Ibn Sina). The first presupposes the presence of certain motives for activity, which are its motivating and guiding components, the second formation of a number of knowledge, skills, design and research activities is possible in two directions: 1) development and improvement of the motivational sphere of activity, the formation of a need for knowledge, the desire to deepen expansion; 2) the formation of the operational side of design and research activities, which includes such means as the development of rational methods, showing the teacher how to work with educational material, solving increasingly complex cognitive tasks, developing the ability to independently acquire knowledge, etc.

In the development of the personality of students, two directions can also be distinguished, namely: the development of the improvement of thinking and the formation of certain personality traits. Since we consider the development of thinking to be a link in design and research activities, we will consider this group of means in detail below.

As for the formation of certain personality traits, such means are used here as design-independent work, solving research problems, creative work, which are specifically aimed at the formation of independence, activity, creativity, enthusiasm and other personality traits.

The second group of means, design - research activities by the mentioned thinkers of the East Farabi, Ibn Sina, is aimed at mobilizing the existing cognitive forces of students. This is achieved in two main ways. One of them is forcing students to complete assignments by various means. This includes threats, punishments, the creation of conditions that force students to actively work in the classroom and do their homework. These means should be classified as negative, because, as it is rightly noted in modern didactics, they give far from stable and deep learning results.

Another way involves the use of means that arouse students' interest in learning [4,5,6,7,8], which is achieved mainly by influencing the motivational and emotional aspects of the student's personality. Here we include the creation of an emotional background in the lesson, problematic presentation of the material, demonstration of experiments at the beginning of the lesson, excursions, design and research work, etc.

The third group of means achieves a certain effect in improving the design and research activities of schoolchildren by creating such learning conditions that remove unproductive time and create an optimal load on the thinking of students, thereby intensifying design and research activities (Al-Beruni, Ibn Sina, Farabi, etc. .).

This group includes various devices that facilitate the work of students (calculating machines, drawing instruments, templates, stencils, computers). This also includes tasks on a printed basis, selective input of answers to a task means that allow for a short period of time to give the required amount of various educational information (video films, filmstrips, sound recordings, posters, tables, mobile applications, etc.).

The main functions of the means that form cognitive activity and improve design and research activity are also understood by thinkers of the East in folk pedagogy: informational and motivational (acquisition of new knowledge); controlling (messages on the degree of mastering knowledge); and finally, to help organize independent project-individual work of students.

RESEARCH METHODS

To solve these problems, the following methods are used:

- analysis of psychological, pedagogical, mathematical and methodological literature on the research topic;

- analysis of the results of mastering knowledge on the problem of studying the topic of project activities of future mathematicians;

- conducting surveys, interviews, tests among teachers and students, analysis of their results;

- Analysis of university documents and familiarization with the experience of teachers.

DISCUSSION

There are various approaches to teaching mathematics courses in higher education using the design method and its essence and significance in the design activities of students, the role it plays in the learning process.

There are two approaches to the relationship between design activity and the design method. For example, E. S. Zair-Bek [9] in his report emphasizes that the design method and project activity are two different concepts and exist independently of each other. Most authors consider the design method and design activities in close relationship.

We consider the design method and project activities of students in their relationship and as a form of organization of their project activities.

At present, new pedagogical technologies are being introduced into educational activities, active teaching methods are used, including the project method. This happens because the educational institution, in which the student is the object of learning, is losing its relevance. In its place comes another educational institution in which students can show their talents and individuality, learn to choose and make decisions.

I.S. Sergeeva [10] believes that such an educational institution faces new challenges. The teacher must create an environment that would motivate students to independently obtain, process information, exchange it, as well as quickly and freely navigate in the surrounding information space. For students, conditions should be created that contribute to their development in various subjects, but at the same time, it is necessary to reduce the load of students. To accomplish these tasks, it is necessary to make the educational process more exciting and interesting, to reveal the significance of the knowledge gained in school and their practical application in life.

H.J. Ganeev [11] argues that, in accordance with the requirements of the new paradigm of education, the main task of an educational institution is to prepare an educated, creative personality capable of continuous development and self-education. This involves the search for new forms and methods of teaching, updating the content of education, including the use, along with traditional methods, of developmental teaching and, above all, the method of projects.

The project method has a long history. Such scientists as A. M. Vasilyeva [12], I. V. Chechel [13], V. A. Dalinger [14], T. K. Smykovskaya [15], E. S. Polat [16], V. M. Rozin [17], L. O. Filatova [18], I. A. Kolesnikova, M. P. Gorchakova-Sibirskaya [19], G. V. Narykova, Safronova T. M. [20], R. Ibragimov, A. Karataev, B. Kalimbetov, T. Kerimbetov[21],

Over time, the idea of the project method has changed, notes V.M. Rozin [17]. From a component of free education, it becomes an important part of a fully developed and structured education system. But its essence remains the same - to stimulate the interest of students in certain problems, involving the possession of a certain amount of knowledge through project activities. In modern pedagogy, the project method is considered as one of the personality-oriented learning technologies that integrates a problem-based approach, group methods, reflective, presentational, research, search and other methods. It is not used instead of systematic subject-based education, but along with it as a component of the education system.

Currently, the authors give different definitions of the concept of "project".

N. Ivanova [22] gives the following definition. A project is an independent creative work of a student, completed from an idea to its implementation with the help of a teacher's advice.

By project activity we mean such activity, which is based on the activation of cognitive and practical components, as a result of which the student produces a product that has a subjective (sometimes objective) novelty.

Project-based learning is the organization of the educational process aimed at solving learning problems by students on the basis of independent collection of information according to these characteristics and interpretation, mandatory justification and adjustment of subsequent productive learning activities, its self-assessment and presentation of the result. At the same time, learning takes on a great personal meaning, which significantly increases the motivation for learning itself.

The main form of project-based learning is the design method, which is variously defined in the literature.

We take the definition of L. O. Filatova [18] as a basis, in which "... the project method is a purposeful, generally independent activity of students, carried out under the flexible guidance of a teacher, aimed at solving a research or socially significant pragmatic problem and obtaining specific result in the form of a material and or ideal product.

In the methodological literature, there are two points of view on what underlies the project method.

The first point of view: the project method is based on the idea of focusing the educational and cognitive activity of students on the result, which is achieved by solving one or another practically or theoretically significant problem for the student.

The second point of view is offered by H.Zh. Ganeev [11]. In his opinion, the project method is based on the development of students' cognitive skills, the ability to independently construct their knowledge, the development of critical and creative thinking, the ability to see, formulate and solve a problem.

V.V. Guzeev [23] notes that the technology of teaching based on the method of projects is one of the possible methods of problem-based learning. According to the author, the essence of this technology is as follows. The teacher sets the students a learning task, thereby presenting the initial data and outlining the planned results. Everything else students do on their own: they outline intermediate tasks, look for ways to solve them, act, compare what they get with the required result, and correct activities.

Based on this, we believe that one of the central places should be given to the activity of the teacher, which is associated with the organization of a system of means that form design and research activities. Not only to transfer students' knowledge, but also to organize and manage the parties of design and research activities of students and mainly independent cognitive activity, at all stages of education, to reveal the content side of the means of control, mutual control, self-control, mutual learning and self-education.

As a result of the mutual influence of specific goals and means of design and research activities on the methods of cognitive activity, an increase in the proportion of methods that form different levels of students' cognitive activity can be noted. Therefore, at the initial stage, such methods of design and research activities are used that bring students to the realization of the need for new knowledge; for this purpose, the teacher can rely on the possibilities of such means of design and research activities as a textbook, teaching instruments, tables, maps, diagrams, diagrams. , use methodological techniques such as presenting logical tasks, creating problem situations; apply frontal conversation or project-independent work, use game situations.

In concrete terms, the system of means that form the design and research activities of students must necessarily be adequate to the goal of the initial stage - the formation of a cognitive motive. However, at this stage, the impact on other components of the design and research activities (forms, content, methods, techniques, components on other methods, self-control and self-awareness) should be carried out.

Thus, the means that form the design and research activity will act as a system only when their selection is carried out taking into account the specific purpose of each stage of educational cognition and, in their unity, they affect each component of the design and research activity of students. This is the essence of the basic starting point for the construction of a didactic system of means that form the design and research activities of students.

The elements of the system developed by us are a set of tools aimed at the formation of all components of design and research activities, taking into account the specific goal of this stage of design and research activities. In our experimental study, we took as a set of means that form the design and research activities of students: educational content; specific methods and techniques, methods of design and research activity; organizational forms of design and research activities. Consequently, the specific means that form the design and research activities of students act in unity and interconnection.

The system we are considering is holistic.

Thus, we have characterized the generalized model of the system of means that form the design and research activities of students, considering it from the standpoint of the main provisions of the theory of activity, the theory of thinkers of the East, folk pedagogy, goals, stages of educational cognition, the unity of the goals of education, methods and forms of education, and, finally, from the standpoint of the basic requirements of a systematic approach. All this ensures the reliability of the didactic substantiation of the system of means that form the design and research activities of students.

RESULTS

It is impossible to characterize all the specific means of design and research activities of students due to their diversity. However, we can name those means of design and research activities that are the main ones. These include the problematic approach of higher education and

the design and independent work of students, the design and research work of students, business games, etc. These tools stimulate all aspects of design and research activities.

Such an understanding is especially acceptable from the point of view of education for the following reasons: in the design and research activities of first-year students, in comparison with the importance of senior students, the stage of live, direct contemplation is more important. The further course of the cognitive process largely depends on the activity of students at this stage. Therefore, one cannot underestimate the need to activate the mental processes (perception, attention) inherent in this stage;

Implementing the ideas of developmental education already in the course of teaching mathematics, more emphasis is placed on stimulating the mental activity of students. However, in its essence, such training is where much needs to be simply learned, and skills in reproductive activity acquired through exercises. Therefore, the work of memory and the role of reproductive activity cannot be ignored;

From the point of view of the course of mathematics, the fact that the nervous system of the first-year student is still weak and the mental performance of relatively directed methods is also important in order to maintain the student's efficiency, his readiness and strength to perform the next tasks.

Thus, in the first course it is necessary to activate both the simplest and more complex cognitive processes. The situation is exactly the same with different levels (knowledge-acquaintance, knowledge-copying, knowledge-skills and knowledge-creativity) of design and research activities. In training, activation is necessary both at its higher and lower levels. Each step of them is needed depending on the specific educational material and specific design and research activities. The development of an idea from the lowest to the highest levels. But this does not mean that we can neglect the lower levels.

Based on the above concepts, we have developed a system of tools that form the design and research activities of students. In defining this system, we paid great attention to the work of the thinkers of the East, folk pedagogy, folk wisdom, the so-called external and internal sides of the design and research activities of students. However, the content of these concepts is somewhat different.

Under the external side of the design - research activity, we mean the stimulation of simpler cognitive processes (perception, attention, etc.) and the maintenance of the student's overall performance. The approaches for this are:

- ensuring the alternation of the work of different nerve centers by alternating different methods, types and techniques of educational work;

-correct relationship between verbal and visual concrete and abstract in the educational process;

- physical culture and musical minutes of rest in the lesson;

- maintaining positive emotions;

- the use of both games and competitions as a didactic technique, etc.

The internal aspects of design and research activities are, first of all, the activation of students' thinking, and in senior courses also the stimulation of their imagination and creativity.

The main methods used for the purpose of internally forming the design and research activities of students are:

- project-independent work of students;

-elements of self-control, mutual control;

-problem approach to teaching students;

-creative assignments (design and research);

- elements of an adaptive learning system, etc.

The system of methods developed by us of the external and internal side of the formation covers the design and research activities of students at all stages: at the stage of live contemplation, during perception and the emergence of ideas; at the stage of abstract thinking, when comprehending and systematizing educational material, when forming conclusions and generalizations; at the stage of reproduction, when applying the learned material.

Even with a well-thought-out system and skillfully used techniques, project-based research activities do not always adequately perceive the teacher's impact planning. Therefore, along with the possibilities and means that form the design and research activities, it is also necessary to study and learn the internal mechanisms of the design and research activities. This is especially important in the initial courses of the university, because in view of the relatively low level of development of the volitional qualities of junior students, one cannot expect him to always consciously, through volitional efforts, strain his strength to the maximum and strive to show his abilities. His voluntary activity must be supported by involuntary activity. And for that and for another it is necessary to know laws of this process.

It is time to know the state of the student's general readiness, which, firstly, is aimed at finding a goal, and secondly, at achieving the goal. The strength of the general internal mechanism of the student's project-research activity depends on the strength of the unmet need. The strength of the special activation aimed at achieving the goal is in close connection with the self-assessment of students and the assessment of the difficulty of the task. The perception of goals is regulated by the student's self-assessment.

Identification of the individual characteristics of special activation (and, in connection with this, successful activity) in the so-called strong and weak students gave us the opportunity to figuratively present the differences in terms of self-assessment with two fundamentally different graphs. If the strong can advance directly from one difficulty to another, the highest one, then we are obliged to the weak in order to achieve the same final goals (or at least the minimum program) to provide the opportunity to advance slowly (zigzag). It is necessary for the weak person, between

alternating difficult tasks, to give easier tasks from time to time, with which he can easily cope. This allows the weak to feel a sense of success, helps to correct self-esteem, introduces self-confidence.

We restrict ourselves to giving below examples of several types of design work in the discipline of mathematical analysis that form the design and research activities of students. Providing students with design work of various types develops the level of their design and research activities. Therefore, we show samples of design work of theoretical and practical content.

1st project work. Natural numbers.

1. What is the basis of modern mathematics? (Numbers)

2. How did natural numbers come about?

3. What number do we get as a result of applying addition and multiplication operations to natural numbers once or several times?

4. Formulate the displacement and distribution laws of multiplication and addition of natural numbers, that is, specify the formulas of the basic arithmetic laws.

5. Give examples of comparing natural numbers with respect to their magnitude. if m and n are two natural numbers, how can they be distributed?

6. Observe how the natural numbers are distributed along the number line, and how they are distributed along each point of the number line?

7. Are the sets of natural numbers infinite?

8. Is it possible to write natural numbers in this way, distributing them into subsets?

8.1 a) odd numbers 8.2 a) prime numbers

8.3 b) even numbers 8.4 b) composite numbers

9. Tell us if you know prime numbers or not:

9.1 Is there a general formula for prime numbers? What is the sieve of Eratosthenes?

9.2 Give examples of decomposing a composite number into prime factors.

10. What do you know about the axiomatic structure of natural numbers?

11. Give examples of the axioms of addition and multiplication.

2nd project work. Integers

1. What are integers? Give an example of the axiomatic structure of integers.

1.1. What is the essence of the concept of a neutral element?

1.2 What is a symmetric element?

1.3 What scientists have conducted research on

2. Give examples of applying operations to integers.

2.1 – $a + (-b) = -a - b = -b - a$

$a + (-b) = a - b = -b + a$

$-a(b + c) = -ab - ac$

$a + 0 = a, a \cdot 0 = 0$

3. What do we know about number systems?

4. What is writing numbers as a positional series?

4.1 In which number system are the following sets of numbers written?

$$4796 = 4000 + 700 + 90 + 6 = 4 \cdot 10^3 + 7 \cdot 10^2 + 9 \cdot 10 + 6$$

4.2Is it possible to write any natural integer in general form as follows?

$$z = a_n \cdot 10^n + a_{n-1} \cdot 10^{n-1} + a_{n-2} \cdot 10^{n-2} + \cdots + a_1 \cdot 10 + a_0$$

4.3 Is the following definition of a rational number correct?

"If p and q are integers, then the ratio or fraction $\frac{P}{q}$ is called a rational number in mathematics"

4.4 Suppose that *a,b,c,d* - are any integers $(b, d \neq 0)$, then $\frac{a}{b}, \frac{c}{d}$ are rational numbers. Do addition, subtraction, multiplication, and division of these numbers follow arithmetic laws?

4.5 Expressions like $\frac{1}{0}, \frac{5}{0}, \frac{-7}{0}$don't make any sense. Are these numbers rational?

4.6 If the fractional parts 10,100,1000,.....etc. are such, then how do we call such fractions?

4.7 To decompose these rational numbers into a decimal fraction, you must divide the numerator of the fraction by the denominator. Consider all the events that occur there, and draw conclusions.

4.8 Give examples of periodic and non-periodic decimals.

4.9 Do you know the properties of rational numbers? Specify three of their properties.

5. Write down real numbers as infinite decimals.

3rd project work

Topic of project work: Applying operations to irrational numbers

Note: addition, subtraction, multiplication, and division operations can be applied to irrational numbers as well as to integers and fractions, but operations on irrational numbers have their own characteristics. First, it is necessary to define the concept of approximate values of irrational numbers. $\sqrt{5} = 2.2$ or $\sqrt{5} = 2.3$, so, respectively $2.2^2 = 4.84$ or $2.3^2 = 5.29$

Complete the following tasks:

1. The area of the square is 16.7 cm^2. Calculate its edges with an accuracy of 0.01 cm.
2. The circumference is 5.6 m^2. Calculate the diameter of the circle with an accuracy of 0.01 m. (let's assume $\pi = \frac{22}{7}$).
3. Find the value of the numbers $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$. Calculate the resulting smallest and largest values with accuracy 0.1 ; 0.01; 0.001; 0.0001; 0.00001; 0.000001; 0.0000001

Follow these steps:

$\sqrt{2} + \sqrt{3} = 1.414 + 1.732 = 3.146$ (manual: addition with an accuracy of 0.001).

$\sqrt{5} - \sqrt{3} = 2.236 - 1.732 = 0.504$ (Manual: subtraction with an accuracy of 0.001).

$\sqrt{3}$ x $\sqrt{2} = 1.732$ x $1.414 = 2.449$

4. Draw the length of the segment $\sqrt{3}$ cm.
5. Draw the following numbers on the numeric line: - $\sqrt{2}$; $\sqrt{3}$; $\sqrt{2} + \sqrt{3}$; $\sqrt{5} - \sqrt{3}$.
6. Follow these steps: 1.1414123...+3.1213456...;

2.71+2.7123; 2.71...+3.14...

Try answering the following questions:

1. Give examples of irrational numbers.
2. What new numbers will we add to the fractional numbers to get a set of irrational numbers? If we add irrational numbers to fractional numbers, what set of numbers do we get?
3. What other name can you give to infinite decimals?
4. What is the name given to a set that has infinite periodic decimals?
5. Give examples of pure and mixed periodic decimals. Is it possible to represent them as an ordinary fraction? Is it possible to convert infinite decimals to an ordinary fraction?

4th project work. Real numbers and their properties

1. Define the concept of real numbers. Which one is a real number? $1,5,10,15,\sqrt{36},\sqrt{49,20},\sqrt{2},\sqrt{-3},\frac{1}{4},-\frac{2}{3};0,45234\ldots,2+3i,4-2i$

2. Is it true that "only a single number corresponds to each point on the number line"?

3. Is it possible to establish a one-to-one correspondence between the entire set of points on a straight line and the entire set of real numbers?

4. Is it possible to consider the set of points on a straight line instead of the set of real numbers, and the set of real numbers instead of the set of points on a straight line?

5. Specify the difference between a segment and an interval? what does [*a,b*] and (*a,b*) mean?

6. If $a \leq x \leq b$ holds, then *x* is what number?

7. Assume that $\alpha = \alpha_0\alpha_1 \dots \alpha_n, \dots$ and $\beta = \beta_0\beta_1 \dots \beta_n$ are real numbers. How do I compare these numbers?

8. Write down the properties of real numbers:

8.1 if *a* and *b* are real numbers, then only one of the following entries holds *a = b, a b, a < b*.

8.2 Write down the sequence property.

8.3 Write down the density property.

5 th project work. Absolute value

1. Explain the essence of the concept of absolute value: $|x|$

2. The absolute value of the sum of two or more terms will be less than or equal to the sum of the absolute values of individual terms, i.e.:

$$|x + y + z + \cdots + u| \leq |x| + |y| + |z| + \cdots + |u|$$

2.1 We consider and prove the case when the number of terms is equal to two:

$$|x + y| \leq |x| + |y|$$

3. The absolute value of the difference will be greater than or equal to the difference of the absolute values of the reduced and subtracted, i.e.:

$$|x - y| \geq |x| - |y|$$

4. The absolute value of the product is equal to the product of the absolute values of the multipliers, i.e. $|x \cdot y| = |x| \cdot |y|$

5. The absolute value of the quotient is equal to the quotient of the division of the absolute values of the divisible and divisor, i.e.:

$$\left|\frac{x}{y}\right| = \frac{|x|}{|y|}$$

6. The characters following the decimal point of a given infinite decimal fraction 0.1123456789101112... are the given natural numbers 1,2,3,4,5,... Prove that this fraction is not a rational number.

7. Prove that the given number $\sqrt{2} + \sqrt{3}$ is an irrational number.

8. Find the approximate value of the given number $\sqrt[3]{3}$.

9. Solve the given equation $|x-1| = |x+3|$.

10. If *a* is the exact value of the measured quantity, and *x* is its approximate value, then the difference *a-x* is called the error of the approximate value of *x*.

If $x \leq a$, then *x* is called the decreasing approximate value, and if $x \geq a$, then *x* is called the increasing approximate value.

11. Why $\Delta_0 = \lceil a - x \rceil$ is called an absolute error

12. What is the relative error? $\delta_0 = \frac{\Delta_0}{|a|}$

13. Give examples of the rounding method. Explain the rounding rule.

14. Exercises

1. Prove that the number $\sqrt{3}$ is irrational.
2. Prove that $\sqrt{5}$ - $\sqrt{2}$ are irrational.
3. Can the sum of two irrational numbers be a rational number?
4. The given value is 0.101001000100001... what's the date?
5. Find the approximate value of the number $\sqrt[3]{5}$.
6. Find the root of the equation |x+3|=| x-5 |.
7. Solve the inequalities: $|x-1| \geq |x+3|$; $|x-2| \leq 2$; $|x-1| \geq 3$

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