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Methods of Storing the Values of Trigonometric Functions

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Annotation: *The article provides guidelines for memorizing the content of concepts when teaching trigonometric materials to schoolchildren, in particular, two methods for memorizing tabular values of trigonometric functions. There are comments on the benefits of the Trigonometry in the Palm and Diagonal Table method. In addition, the article describes illustrative and cognitive methods and mechanisms of mnemonic movement in the development of logical memory. The role of memorizing mathematical concepts in revealing the mechanism of logical constructions and the development of students' skills to form and prove mathematical sentences (axioms, statements and theorems) is determined by illustrative and cognitive methods, such as "Trigonometry in the palm of your hand" and "Diagonal table".*

Key words: *trigonometry, mnemonic movement, illustrative and cognitive methods, axioms, pospulat and theorems, methods of scientific research and inference.*

Introduction: trigonometry is of great importance in the school mathematics course. Trigonometric issues occupy a significant place in higher education entrance tests and mathematics Olympiads. While this is the case, schoolchildren have difficulty learning trigonometry. The reasons for this depend on many factors, the main thing is not to memorize the values of trigonometric formulas and trigonometric functions, which cannot ensure the consistency and continuity of mathematical knowledge. One of the main pedagogical tasks of the teacher is the development of students ' thinking and the implementation of this process through various illustrative-cognitive methods [1]. The main methodology for the study of trigonometry is the study of trigonometric functions with a unit circle, as well as with illustrative interpretation, and the drawing of their graphs, the visual presentation of information. Therefore, when organizing the course process, it is necessary to take into account methods and rules aimed at interpreting the principles of exhibitionism.

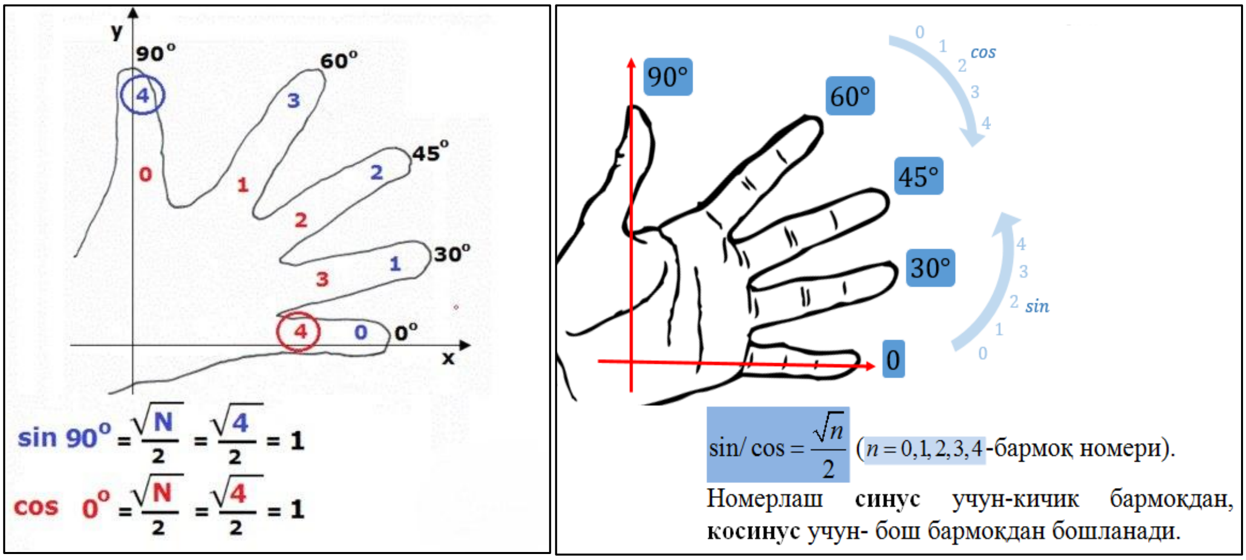
Literature review: The school offers developments by many researchers on methodological problems of the study of trigonometry. For Example, N.I.Popov, A.N. Marasanov's research focuses on the importance of a methodological approach to teaching trigonometry. In this case, proposals are made for the methodological support of educational literature and its improvement [4]. A.G. Mordkovich, on the other hand, offers a unique approach to the study of trigonometry. In his opinion, the study of trigonometry should be carried out on the basis of the following sequence: 1) the study of trigonometry begins with a unit circle in the plane, that is, the introduction of basic concepts using it; 2) mainly focus more on trigonometric shape substitution; 3) the process of studying basic trigonometric formulas is intended to be studied after the introduction of the concept of unit circle and simple trigonometric equations [5]. Research by Kevin Moore, a researcher at the University of Arizona, recommends a methodology for developing students ' computational skills in studying the basic concepts of trigonometry. The study shows the dynamics of the development of students ' logical thinking through a sequence of studies of the proposed developmental and trigonometric functions. We believe that it will be effective to memorize basic learning concepts to facilitate the study of trigonometry and ensure systemicity, continuity, analyzing the developments of many researchers.

Research Methodology: In the process of mathematical education, scientific research(experiment and observation, comparison, analysis and synthesis, generalization, abstraction, clarification, classification, systematization) and methods of inference (induction, deduction, analogy) naturally form the arsenal of human thought techniques [3]. Memorizing the content of a mathematical concept reveals the mechanism of logical constructions of this concept and develops the student's ability to formulate, prove mathematical judgments (axiom, pospulate and theorem). Sections of the school mathematics course have different difficulty levels, and especially the majority of students have problems studying trigonometry sections. In this situation, the teacher should apply illustrative, primitive methods of teaching in the course of the lesson, form the students ' ability to memorize, provide various practical aspects of trigonometry. The formation of students ' ability to memorize strongly influences their not yet awakened mathematical thinking and leads to an awareness of the importance of trigonometry, in particular an increase in motivation. The fact that the formation of the ability to memorize is the main factor in the development of thinking is demonstrated by many psychologist scientists (P.I. Zinchenko, I.F. Kashlach, W.Ya. Liaudis, M.S. Rogovin, A.A. Smirnov et al. The process of developing the logical memory of students is considered as the formation of methods for organizing educational activities on the basis of memorization and, through this, the establishment of semantic connections, relationships in the educational material. The memorization process itself is characterized by the functions of storing and strengthening the educational material in memory, as well as the functions of its development. Perhaps the problems that arise in the study of trigonometry sections at school may be the lack of memorization by the student of the main teaching materials and formulas in this section. Because initially memorizing the values of the basic trigonometric formulas and trigonometric functions will open the way to the study of later topics. Trigonometry occupies one of the central places in the school mathematics course in terms of the scale of the content and relevance of educational material. As a result of the analysis, trigonometric issues account for 10-23% of Higher Education Entrance Tests. In solving some tests, however, one has to rely on trigonometry. It is known that the process of studying preliminary trigonometric concepts begins with the examination of the sine, cosine, tangency and cotangency of the angles of the Triangle in geometry lessons by students of the 8th grade. The process of studying trigonometry is also continued in the upper classes, in particular the trigonometric equations and inequalities, extended by their system and provided consistency and continuity of educational content. One of the problems faced by students in the early stages of learning trigonometry is the need to memorize the values of trigonometric functions for Angular values (0º, 30º, 45º, 60º, 90º). Psychologist A.A. Smirnov believes that memorizing information activates the student's cognitive activity. Not memorizing and remembering the necessary parts of the learning material will cause it to be quickly forgotten [2]. Therefore, in order to constantly remember any trigonometric material, it will be necessary to provide a system of contacts of educational activities that form a mnemonic action (methods that increase the productivity of memory and process memorized material). The importance of the mnemonic memorization technique in the school mathematics course and its properties have been studied by many Methodists (O.B. Episheva [5], I.F. Kashlach [4] et al. The properties of the iodized material must lie on the basis of a mathematical model built through its system of mnemonic movements. As mechanisms of mnemonic behavior in the development of logical memory, the following are recommended: organization of educational activities that lead to the division of educational material into semantic groups and frequent repetition, comparison, classification, systematization, analogy and linking memorized information to some object, etc. Based on the above, the identification of illustrative-cognitive methods, the development of practical recommendations, which make it easier for students to memorize the "table" values of trigonometric functions, is considered as one of the methodological problems. We bring readers several methods that make it easier to memorize the values of trigonometric functions.

Method 1. In this case, memorization of the angular values of the sine, cosine, tangent and cotangent is carried out using the mnemonic rule “trigonometry in your palm". Through this rule, it is much easier to memorize the values of sine, cosine, tangent and cotangent at 0º, 30º, 45º, 60º, 90º degrees. The rule is as follows: starting with the little fingers of our left hand, the thumb is numbered from 0 to 4. Let the little finger-0º, the unnamed finger-30º, the middle finger-45º, the pointing finger-60º and the thumb-90º. This simple $\sin/\cos = \frac{\sqrt{n}}{2}$ (here $n = 0,1,2,3,4$) using the formula. Sinusning 0º, 30º, 45º, 60º, 90º from a small comma to calculating the values in degrees upwards by the numbering of the fingers $\sin x = \frac{\sqrt{n}}{2}$ we find using the formula. For example,

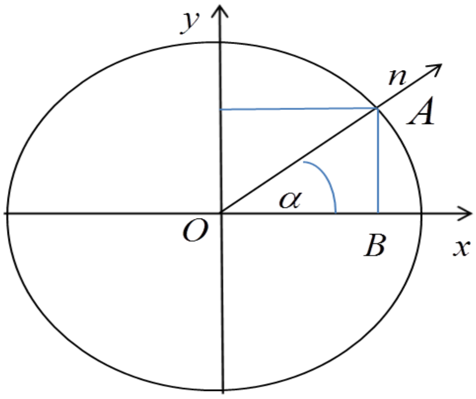
$$\sin 0^0 = \frac{\sqrt{0}}{2} = 0, \quad \sin 30^0 = \frac{\sqrt{1}}{2} = \frac{1}{2}, \quad \sin 45^0 = \frac{\sqrt{2}}{2}, \quad \sin 60^0 = \frac{\sqrt{3}}{2}, \quad \sin 90^0 = \frac{\sqrt{4}}{2} = 1.$$

Cosinus 0º, 30º, 45º, 60º, 90º to calculate the values in the grades, finger numbering is done in reverse, i.e. starting with the thumbs, the little finger is numbered from 0 to 4. By finger numbering $\cos x = \frac{\sqrt{n}}{2}$ using the formula, the values of cosine at 0º, 30º, 45º, 60º, 90º degrees are found (Figure 1).



When calculating the graded values of the tangent and the cotangent $tgx = \frac{\sin x}{\cos x}$ and $ctgx = \frac{\cos x}{\sin x}$ formulas are used.

Now, in the development of logical memory, we will bring another of the methods aimed at the implementation of mnemonic actions, in particular, that will make it easier for students to memorize the "table" values of trigonometric functions. Method 2. A unit circle is drawn, the center of which is in a system of right-angled kooordanas. let the light passing through the point cut the unit circle at the point so that it forms an angle with the positive direction of the abscissa axis (Figure 2).



OAB from the Triangle $\sin\alpha = y,\ \cos\alpha = x$. The "table" values are found only in the first quarter, using the periodicity of the trigonometric functions to the values found πn ($n = 0, \pm1, \pm2, ...$) the values that add up the number can be found. This method is based on the definition of sine, cosine, tangent and cotangent. For example $\sin 0^0 = 0$ ga and $\cos 0^0 = 1$ is equal because n nur OX overlaps the axis. If n nur OX with Axis 30^0 if the angle is formed, OAB from the Triangle 30^0 using the fact that the catheter lying opposite the angle is half the hypotenuse $\sin 30^0 = AB = \frac{1}{2}$ comes from. $\cos 30^0 = OB$ the value is found using Pythagorean theorem: $\cos 30^0 = OB = \sqrt{OA^2 - AB^2} = \sqrt{1 - \frac{1}{4}} = \frac{\sqrt{3}}{2}$. If n nur OX with Axis 45^0 if the angle is formed, OAB the triangle becomes an equilateral right triangle: $\sin 45^0 = \cos 45^0 = OB = AB$. By Pythagorean theorem $OB = AB = \sqrt{\frac{1}{2}} = \frac{\sqrt{2}}{2}$. If n nur OX with Axis 60^0 if the angle is formed, then OAB from the Triangle $\angle OAB = 30^0$ is, and the catheter opposite it is half the hypetenuse: $OB = \frac{1}{2} = \cos 60^0$. According to the Pythagorean theorem $AB = \sqrt{OA^2 - OB^2} = \sqrt{1 - \frac{1}{4}} = \frac{\sqrt{3}}{2} = \sin 60^0$ origin. If n nur OX with Axis 90^0 if the angle is formed, $AB = 1 = \sin 90^0$ va $OB = 0 = \cos 90^0$. So that the values of the sine and cosine are in reverse order.

To make it easier for students to memorize the values of trigonometric functions, it is good to present them in the form of a table and describe the values in it diagonally (Table 1). Such a table speeds up the search for the desired values, since no other values are listed in this table. Table 1.

$\cos\alpha$ / $\sin\alpha$	0^0 ($0\ rad$)	30^0 ($\frac{\pi}{6}\ rad$)	45^0 ($\frac{\pi}{4}\ rad$)	60^0 ($\frac{\pi}{3}\ rad$)	90^0 ($\frac{\pi}{2}\ rad$)
0^0 ($0\ rad$)					0
30^0 ($\frac{\pi}{6}\ rad$)				$\frac{1}{2}$	
45^0 ($\frac{\pi}{4}\ rad$)			$\frac{\sqrt{2}}{2}$		

60^0 ($\frac{\pi}{3}$ rad)		$\frac{\sqrt{3}}{2}$			
90^0 ($\frac{\pi}{2}$ rad)	1				

Analysis and results: In order not to confuse where to write sine and cosine in this table 1, it is necessary to write them in the situation where their axes are located, that is, the sine is placed in a vertical column, the cosine in a gorizantal column. The use of such illustrative mnemonic techniques in the course of the lesson gives good results for students. Memorization of values of trigonometric functions in particular allows students to achieve high activity in the classroom, their interest in trigonometry and mathematics in general, and a significant increase in knowledge, skills and competence [3].

Conclusion and Recommendations: In conclusion, the use of such illustrative-cognitive methods in memorizing the values of trigonometric functions expresses the coherence of the purpose, content, organizational forms, methods and laws of the didactic process. To strengthen, the following tasks are recommended: 1) Find the value of the expression:

1) $2\sin 45^0 - 3tg30^0 + \cos 60^0$

2) count:

$$\sqrt{\left(2\sin 45^0 - 3\right)^2} + \sqrt{3\cos 45^0 - \sin 90^0} + tg60^0 + \sin 180^0 + \sqrt{\sin 270^0 + tg30^0} + ctg60^0$$

3) check the correctness: $\sin 45^0 + \cos 30^0 > 1$.

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