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Research Article

BASED ON AN INTEGRATIVE APPROACH TO TRIGONOMETRY EXAMPLES AND EXERCISES APPLICATION OF FRACTION PROPERTIES

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ABSTRACT

Recommendations on the method of using fractions, equivalent formulas, series of equivalent ratios, inverse trigonometric functions, the largest and smallest values and finite trigonometric series in order to apply the theoretical part of the science in practice, that is, to increase the skills of solving examples and problems, were highlighted.

KEYWORDS

Fractions, trigonometric solutions to geometric problems, radius, perimeter, face of a circle inscribed outside a triangle.

INTRODUCTION

In general secondary schools and academic lyceums, fractions are taught in the mathematics course, covering topics such as comparing fractions, operations on fractions, rational numbers, decimal fractions, and their combinations. The didactic methods of teaching these topics are essential in implementing the unity of theory and practice in education, emphasizing the significance of teaching from the perspective of theory [4].

During the periods, educational programs were carried out in a traditional way, that is, lectures were carried out through large books and manuals. This, in turn, has

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weakened the issue of ensuring that the quality of education is as high as possible. In modern education, special attention is paid to the process of digitization of education in order to increase the quality indicators of education. The current state of the education system is characterized by the increasing role of non-traditional educational technologies. Learning by the learner with their help is much faster than with traditional technologies. These technologies change the nature of knowledge development, acquisition and distribution, deepening and expanding the content of the studied subjects, quickly updating it, using more effective teaching methods, and also significantly expanding the opportunity for education for everyone will give [3].

In the current educational landscape, practical exercises on fractions are utilized in mathematics lessons for various topics. In addition to the basic mathematics, algebra, and geometry courses, selected topics in Trigonometry are introduced for 4th-year students in higher education, where practical skills in applying trigonometry to geometric problems are emphasized. Specifically, equivalent formulas and ratios are employed to address fundamental problems in the field.

The application of the sine theorem for triangles allows expressing trigonometric elements for each side through angles. The relationships are substantial and can be derived using the sine theorem $\alpha+\beta+\gamma=\pi$, leading to equivalent relationships. Utilizing the sine theorem, if we substitute angle *a* with the side opposite to the triangle and the corresponding face, the formula

$$\frac{a}{\sin\alpha}=\frac{b}{\sin\beta}=\frac{c}{\sin\gamma}=2R \quad (1)$$ emerges.

Further, by substituting the left side of $\frac{a}{\sin\alpha}=2R$ into the formula, we obtain the equation

$$\frac{2S}{h_a\sin\alpha}=2R \qquad (2).$$

Simplifying the (2) equation by shortening both sides with the tangent of half the angle

$$S=h_aR\sin\alpha \qquad (3),$$

we can express it as 2R, as shown in formula

$$2R = \frac{h_a}{\sin\beta\sin\gamma} \quad (4).$$

The equivalence ratios for 2R were derived earlier as $2R = \frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma} = \frac{2S}{h_a\sin\alpha} = \frac{h_a}{\sin\beta\sin\gamma}$ [1].

By substituting this information into the equation

$$p = \frac{a+b+c}{2} = \frac{2R(\sin\alpha+\sin\beta+\sin\gamma)}{2} = R\left(2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2} + \sin(\pi-(\alpha+\beta))\right) =$$

$$= R\left(2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2} + \sin(\alpha+\beta)\right) = R\left(2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha-\beta}{2} + 2\sin\frac{\alpha+\beta}{2}\cos\frac{\alpha+\beta}{2}\right) =$$ we find an

$$= 2R\sin\frac{\alpha+\beta}{2}\left(\cos\frac{\alpha-\beta}{2} + \cos\frac{\alpha+\beta}{2}\right) = 4R\sin\frac{\pi-\gamma}{2}\cos\frac{\alpha}{2}\cos\frac{\beta}{2} = 4R\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}$$

equivalent ratio for the perimeter of the triangle in terms of 2R

$$2R = \frac{p}{2\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}} \quad (5)$$

with the given lengths of the sides and the external circumradius, the formula for calculating the area

$$S = \frac{abc}{4R} \quad 2R = \frac{abc}{2S} = \frac{2R\sin\alpha\cdot 2R\sin\beta\cdot 2R\sin\gamma}{2S} \Rightarrow \quad 2R = \sqrt{\frac{S}{2\sin\alpha\sin\beta\sin\gamma}} \quad (6)$$

is obtained.

We get the equivalent ratios obtained above:

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$$2R = \frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma} = \frac{2S}{h_a \sin\alpha} = \frac{h_a}{\sin\beta\sin\gamma} = \frac{p}{2\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}} = \sqrt{\frac{S}{2\sin\alpha\sin\beta\sin\gamma}}$$

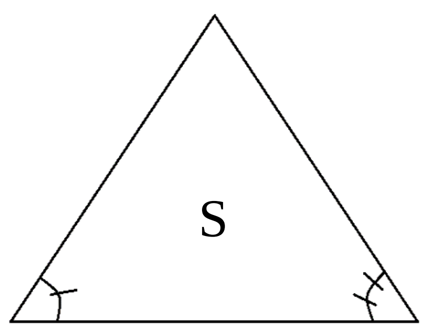
In geometric problems, there is a connection between the area and perimeter of a triangle through its sides, but there is no direct connection between the angles. This problem can be addressed through the application of trigonometric equivalent ratios. In other words, we utilize the fundamental property of fractions for this equation,

$$\frac{p}{2\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}} = \sqrt{\frac{S}{2\sin\alpha\sin\beta\sin\gamma}},$$

applying the product of the tangent of half-angles and using the connection between the acute angles to determine

$$S^2\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2} = p^2\sin\alpha\sin\beta\sin\gamma \qquad S = p^2 tg\frac{\alpha}{2}tg\frac{\beta}{2}tg\frac{\gamma}{2}$$

Problem 1: For any given triangle with the area , and two angles and provided, determine its perimetr.



Solution: In this problem, the area and perimeter of the triangle are related through its sides and the internal circumradius. Although there are no formulas directly connecting the area and perimeter to the angles between the sides, we can employ equivalent ratios established for the external circumradius of a triangle, as explained before.

$$2R = \frac{p}{2\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}} = \sqrt{\frac{S}{2\sin\alpha\sin\beta\sin\gamma}}$$

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We will determine the relationship between the product of the acute angles' tangents in this triangle and the perimeter by utilizing the product of tangents, aiming to define this connection accurately:

$$p^2 2\sin\alpha\sin\beta\sin\gamma = 4S\cos^2\frac{\alpha}{2}\cos^2\frac{\beta}{2}\cos^2\frac{\gamma}{2}$$

$$p^2 = \frac{2S\cos^2\frac{\alpha}{2}\cos^2\frac{\beta}{2}\cos^2\frac{\gamma}{2}}{\sin\alpha\sin\beta\sin\gamma} = \frac{2S\cos^2\frac{\alpha}{2}\cos^2\frac{\beta}{2}\cos^2\frac{\gamma}{2}}{8\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}\sin\frac{\beta}{2}\cos\frac{\beta}{2}\sin\frac{\gamma}{2}\cos\frac{\gamma}{2}} =$$

$$= \frac{S\cos\frac{\alpha}{2}\cos\frac{\beta}{2}\cos\frac{\gamma}{2}}{4\sin\frac{\alpha}{2}\sin\frac{\beta}{2}\sin\frac{\gamma}{2}} = \frac{1}{4}Sctg\frac{\alpha}{2}ctg\frac{\beta}{2}ctg\frac{\gamma}{2} \qquad p = \frac{1}{2}\sqrt{Sctg\frac{\alpha}{2}ctg\frac{\beta}{2}ctg\frac{\gamma}{2}}$$

$$P = 2p \qquad P = \sqrt{Sctg\frac{\alpha}{2}ctg\frac{\beta}{2}ctg\frac{\gamma}{2}}$$

It is possible to find the third angle from the equation stated here $\alpha+\beta+\gamma=\pi$ [2].

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