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Section 5. Secondary school

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TEACHING SCHOOL CHILDRENS THE PROOF OF GEOMETRIC PROBLEMS

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Abstract

The work is devoted to teaching schoolchildren's how to refute the proposed proof. This uses a technique known as "giving a counterexample". By counterexample we mean an object for which the condition of the statement is true and the conclusion is false.

Keywords: *refutation of evidence, giving a counterexample, equilateral triangle, rectangle*

Introduction

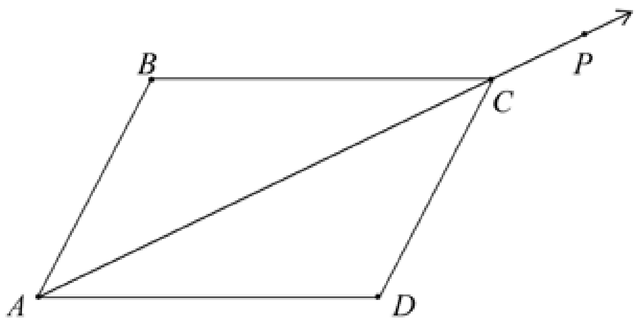
Today to improve the quality of teaching mathematics is one of biggest challenges faced in the field of education. To do so, you have to diversify the process of teaching, to improve the methods of teaching, to start using new approaches for some problems. Let us note works (Aliyev, S., Heydarova, M. and Aghazade, Sh. Solving geometry problems by alternative methods in mathematics education. European Journal of Pure and Applied Mathematics,— 16 (2): 1110–1117, 2023; Aliyev, S., Tahirov, B. and Hashimova, T. Variative problems in teaching mathematics. European Journal of Pure and Applied Mathematics,— 15 (3): 1015–1022, 2022; Aliyev, S., Aghazade, Sh. and Abdullayeva, G. Using area method in secondary school geometry. European Journal of Pure and Applied Mathematics,— 14 (2): 601–607, 2021; Aliyev, S., Hamidova, Sh. and Abdullayeva, G. Some applications of Ptolemy's theorem in secondary school mathematics. European Journal of Pure and Applied Mathematics,— 13 (1): 180–184, 2020; Dr. Anice James. Methods of teaching mathematics. Pub. Neelkamal, 2016.— 432 p; Bremigan, E.G., Bremigan, R.J., Lorch, J.D. Mathematics for secondary school teachers, Pub. The Mathematical Association of America, 2011.— 442 p), which are devoted to the study of these issues.

When refuting the formulation of a theorem, the must common technique is known as "giving a counterexample". By counterexample we mean an object for which the condition of the statement is true and the conclusion is false. To be convinced of the falsity of a statement, you need to find at least one object for which the condition turns out to be true and the conclusion is false.

Sometimes a special form of giving a counterexample is used, the essence of which is that the counterexample itself is not given, but the method of constructing it is indicated. Let's give an example: refute the statement: in a parallelogram, the diagonal bisects its angles.

Let's carry out the following construction: let's draw an arbitrary angle BAD and draw a ray AP inside it, which is not is bisector. On this ray we mark an arbitrary point C and draw straight lines through it parallel to the sides of the angle BAD. The resulting figure is a parallelogram in which the diagonal AC does not bisect its angle.

Figure 1. *(AC diagonal of a parallelogram ABCD)*

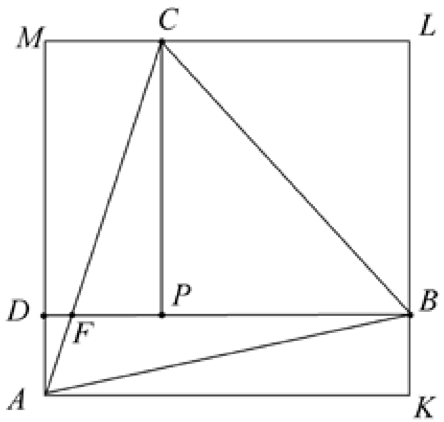


Let us note that refuting a thesis does not mean completely denying it and discarding it as a false statement. In some cases it can be clarified. In our example, the above construction shows that the statement will be true if the parallelogram is a rhombus.

Along will the considered technique of giving a counterexample, you can use indirect techniques to refute statements. Let's explain them.

Let triangle ABC be inscribed in a rectangle $AMLK$. Let us draw through point B a straight line BD parallel to side AK, intersecting the segments AM and AC at points D and F, respectively. On the other side let $CP \perp BD$. Then

Figure 2. *(Equilateral triangle ABC be inscribed in a rectangle AMLK)*



$$S_{AFB} < S_{ADB} = \frac{1}{2} S_{AKBD},$$

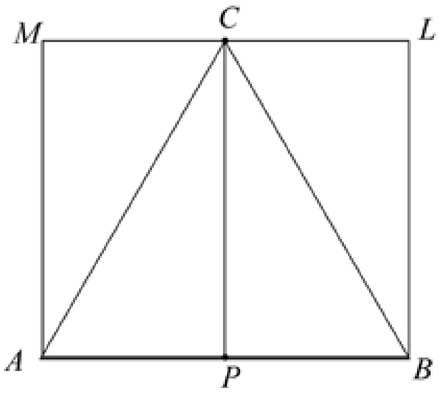
$$S_{FCB} = \frac{1}{2} FB \cdot CP < \frac{1}{2} BD \cdot CP = \frac{1}{2} S_{DBLM}.$$

From here

$$S_{ABC} = S_{AFB} + S_{FCB} < \frac{1}{2} S_{AKBD} + \frac{1}{2} S_{DBLM} = \frac{1}{2} S_{AKLM},$$

$$S_{ABC} < \frac{1}{2} S_{AKLM}.$$

Figure 3. *(Equilateral triangle ABC be inscribed in a rectangle AMLB)*



The found special case refutes the stated statement, which another special case can lead to.

Let equilateral triangle ABC be inscribed in a rectangle $AMLB$ be as in the Figure 3. Let us draw $CP \perp AB$. Then

$$S_{ABC} = \frac{1}{2} AB \cdot CP = \frac{1}{2} S_{ABLM}.$$

When solving not only physical, but also geometric problems, a good and simple means of self-control is "checking by dimension". In any formula, the quantities written on the right and left sides must have the same dimension. This consideration allows us to immediately refute some hypotheses that arise when searching for mathematical patterns. For example, it is known that the area of a triangle with sides a,b,c is calculated using Heron's formula

$$S = \sqrt{p(p-a)(p-b)(p-c)},$$

where p is the semi-perimeter of the triangle. A hypothesis arises that the area of a quadrilateral with sides a,b,c,d is calculated by the formula

$$S = \sqrt{p(p-a)(p-b)(p-c)(p-d)}.$$

Comparison of the dimensions of both parts rejects this hypothesis.

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