

# Teaching Mathematics with GeoGebra

---

**Monica Petre**

Math Teacher

Pedagogical High School, Tulcea, Romania

[monicaxyzpetre@yahoo.com](mailto:monicaxyzpetre@yahoo.com)

It is not any secret that geometry, and especially locus problems are considered to be a kind of “mathematics niceties”, or even annoying, troublesome problems for students taste. All teachers have tried different teaching methods and programs to make students understand this formal geometry, sometimes with success and sometimes not. Computer can really help in geometry teaching, because the students can move, rotate, or stretch the figure, and observe what properties stay the same. There exists a lot of commercial software specially designed to teach geometry, I want to present you now the benefits of GeoGebra, “who is dynamic mathematics software for all levels of education that joins arithmetic, geometry, algebra and calculus. On the one hand, GeoGebra is an interactive geometry system. You can do constructions with points, vectors, segments, lines, conic sections as well as functions and change them dynamically afterwards”( Markus Hohenwarter).

## 1. The statement of the first problem

On the line segment AB is considered the mobile point M and there are built the squares AMCD, BMEF on the line segments AM and BM on the same side of AB.

After the investigation with geogebra software, that is after having selected many positions for M on the line segment AB we can notice the locus of P. In this case we can even mark the limits of the locus by choosing for M the extreme positions: for  $M=A \Rightarrow P=P_1$  and for  $M=B \Rightarrow P=P_5$  (Figure 1). So, the locus of P is the segment  $P_1P_5$  parallel with AB.

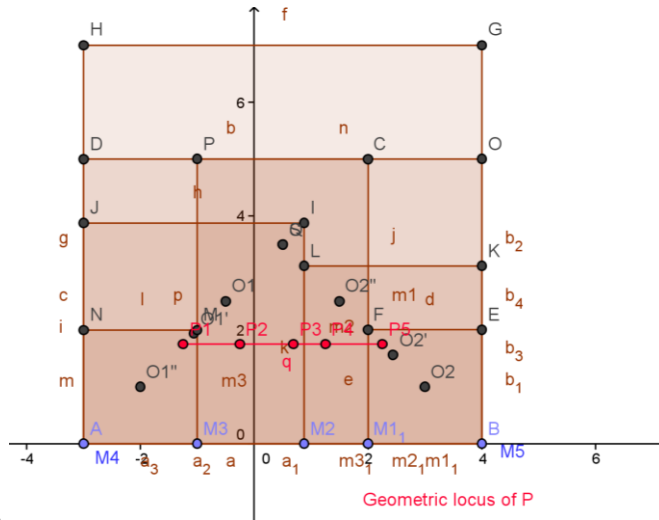


Figure.1

### The mathematical solution (elementary level)

Let  $O_1$  and  $O_2$  be squares centers  $AMCD$  and  $BMEF$ , and  $I_1$  and  $I_2$  their projections on the  $AB$ . Then  $O_1I_1 = \frac{1}{2}AM$  and  $O_2I_2 = \frac{1}{2}BM$  (Figure 2). If  $P$  is the middle point for  $O_1O_2$  and  $I$  it is the projection of  $P$  on  $AB$  segment, then

$$PI = \frac{1}{2}(O_1I_1 + O_2I_2)$$

and

$$PI = \frac{1}{4}(AM + MB) = \frac{AB}{4} = \text{constant}.$$

So, the locus of  $P$  is the line parallel with  $AB$ .

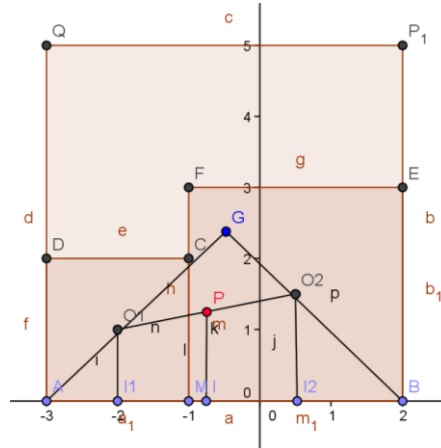


Figure 2

## 2. The second problem statement

In an equilateral triangle of side “a” it is inscribed an equilateral triangle of a minimum area.

Even though the soft cannot solve problems of “extreme” (or, at least, I haven’t discovered this resource) the students can still make some investigations by selecting different position for D on the line segment AC, and comparing the estimated area, will notice the area will become smaller when one of the vertexes of the equilateral triangle inscribed in the initial triangle is the midpoint of the side AC.

Maybe, in the future, we’ll be able to create some new tools using the GeoGebra soft, so that we’ll can solve even problems of “geometric extreme” which are a chapter pretty difficult for students.

### The mathematical solution (elementary level)

Let  $AD=CF=BE=x$  ( Figure 3).

Area of equilateral triangle DEF is:

$$S = \sigma[ABC] - 3\sigma[ADE] \Rightarrow AD = x, AE = a - x, EP = (a - x) \frac{\sqrt{3}}{2}.$$

So  $S = \frac{a^2\sqrt{3}}{4} - 3 \cdot \frac{x}{2} (a - x) \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{4} (3x^2 - 3ax + a^2)$  and trinomial  $3x^2 - 3ax + a^2$  has a minim for  $x = \frac{a}{2}$  and  $S = \frac{\sqrt{3}}{16} a^2$ .

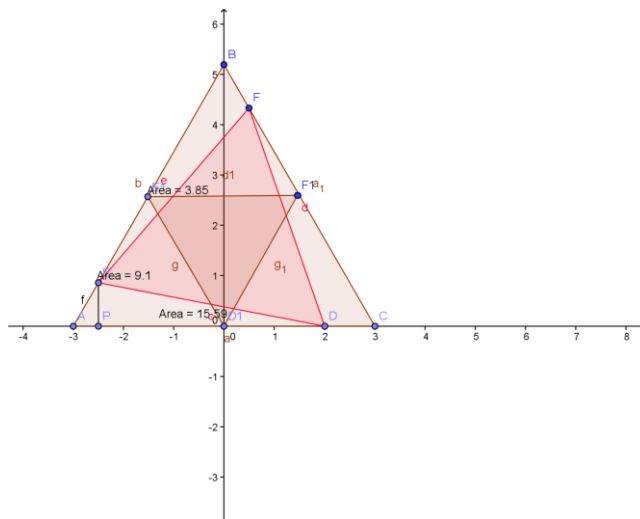


Figure 3

### 3. The third problem statement

For any triangle ABC, [AD and [AD' are internal and external bisectors for angle  $\widehat{BAC}$ . The locus of a point M moving so that  $MB/MC=AB/AC$  ( $\neq 1$ ) is a circle contained points A, D and D' called the Circle of Apollonius.

#### The mathematical solution (elementary level)

By bisectors theorem result  $AB/AC=BD/BC$ , so  $MB/MC=BD/BC$ , so [MD is internal bisector for angle  $\widehat{BMC}$ . Similarly, using external bisector theorem and  $MB/MC=AB/AC \Rightarrow [MD'$  is the external bisector for angle  $\widehat{BMC}$ . So,  $m(\widehat{DMD'})=90^\circ$  and because D and D' are fixed, M is belongs to the circle of diameter [DD'].

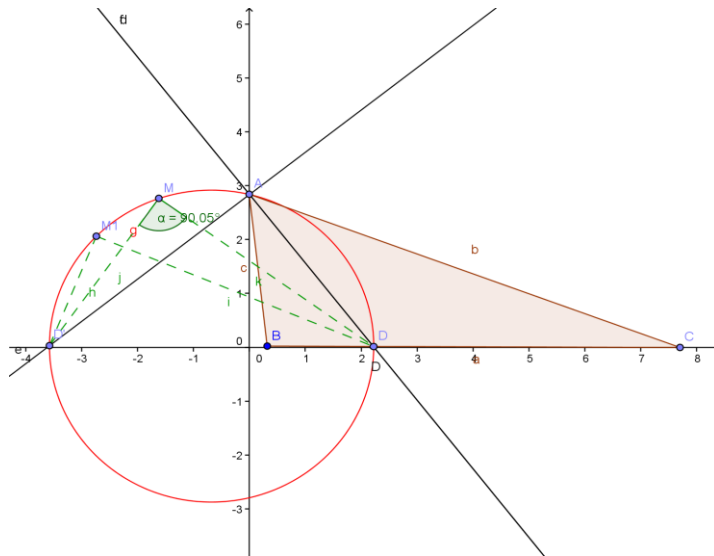


Figure 4

This is a wonderful theorem in plane geometry, and the demonstration that any point on the circle belongs locus is very interesting but it is ,of course, well known. What I want to emphasize here, it is that the determination by intuition of the locus of M by choosing many positions form and noticing that the angle DMD is always constant( $90^\circ$ ),so the locus of M is the circle of diameter [DD'].

## **Conclusion**

"The task of education and training based on the new information and communication technologies is not to demonstrate that it has immediate results in a competition with other educational systems, but to replace some of the current structures with a new, probably higher spectrum performance, to meet the inherent changes that occur in culture and civilization. "

This is the purpose of using Geogebra software at class, to expand the boundaries of creativity in teaching-learning-assessment, to use the power of information technology to stimulate students' Imagination and facilitate the transfer of learning to everyday life.

Surely the mere use of the software will not help us much if it is not combined with teaching techniques, with student-centered teaching methods, with active learning methods such as solving problems creatively, critical thinking, learning through discovery, through practice, learning through experiments. The entire context must be well analyzed and then we will decide on the opportunity to use the computer, as this is the only way certain problems that occur in a traditional lesson can be avoided, such as: the students low interest and the very theoretical character of the lessons.

## **References**

Simionescu, Gheorghe, "Synthesis problems of plane and space geometry", Technical Publishing, Bucharest, 1978, Romania

Nicolescu, Catalin-Petru, Synthesis of mathematics, Albatros Publishing, Bucharest, 1990, Romania

Nicolescu, Liviu; Boskoff, Vladimir," Practical problems of geometry", Technical Publishing, Bucharest, 1990, Romania

Istrate, Olimpus, "Distance learning. Designing materials, Agata Publishing, 2000, Bucharest, Romania