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On the Design of 2D Dynamic Drawings with Euklid DynaGeo

Engin CAN*[1]

Abstract

Nowadays in the plane geometry with the advancement of technology, the geometric constructions are designed and processed using the 2D dynamic geometry software’s (DGSs). In order to use such programs, users should have the necessary information and skill. In this paper, pieces of information some of the known software are given, but more proposed Euklid DynaGeo is presented, in which users can draw and recognize the function graphs more easily. For this aim, some applications are displayed and finally, clearly presented how Euklid DynaGeo serves the users to realize the constructional geometrical drawings.

Keywords: dynamic geometry software, Euklid DynaGeo, plane geometry, 2D construction, mathematics education

1. INTRODUCTION

Sometimes geometric definitions and theorems are especially for students very abstract and difficult to understand. Because of this, interest in geometry decreases and leads to poor performance. Using computers as supporting materials on education by increasing opportunities for technology could be made abstract theories more understandable. The researchers have discovered that the results of success are quite effective in using dynamic geometry software [1-8]. Therefore, some lectures are with computer applications supported, which continuously user-friendly developed and designed. So, scientific concepts could be taught and learned by computer-aided instruction (CAI) [9]. The introduction of DGS in geometry teaching requires that instructors have technical knowledge in dealing with DGS and in the conceptual understanding of mathematics. Thus, also teachers run into a number of new challenges [10-12].

Just before the 20th century, such DGS first by Geometric Supposer and Cabri, later on by The Geometer’s Sketchpad was developed. Overtime many software programs by the advancement of computer hardware and software have been developed with the cooperation of good programmers and academics, who have knowledge of geometry. The main types of computer environments for studying school geometry are supposers, dynamic geometry environments (DGEs) and Logo-based programs [13]. Especially with drag feature by DGEs provides users to manage the geometric object into different positions. There are many free- and

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shareware 2D DGSs frequently used today. Some of them are Cabri, Cinderella, GeoGebra, CaRMetal, GEX and DrGeo.

The rest of this paper is created as follows: In the next section, the proposed software is presented. In section 3, three application examples are demonstrated and pointed up, if a construction displayed as an application (or proof of a geometric theorem in 2D) then with the drag option could be shown that for all other positions of the construction is valid.

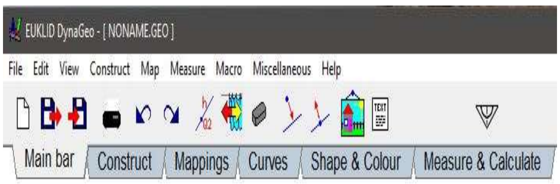
2. EUKLID DYNAGEO IN BRIEF

Euklid DynaGeo is a computer program about "dynamic geometry" that gives us the possibility to design drawings i.e. drawings in which (some) objects can be dragged to a new position without losing the mutual of the geometrical objects during the preceding construction. It is useful to create various geometric objects, constructions, even mappings, measure distances and angle widths, calculate and watch expressions, etc.

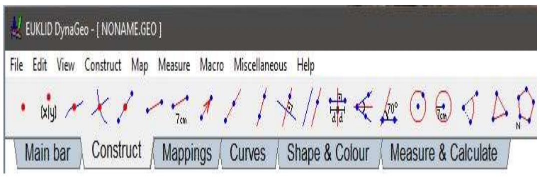
Moreover, it is possible creating trace lines, working with conics and affine mappings, creating macros for repetitive commands of constructions, animating drawings to demonstrate transformations and more [14].

The toolbar configurations and icons of Euklid DynaGeo look like as follows:

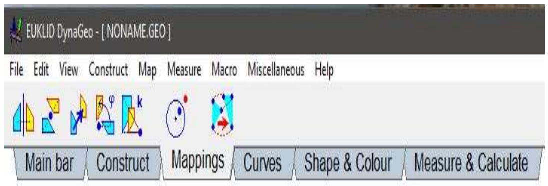
1. Main bar:



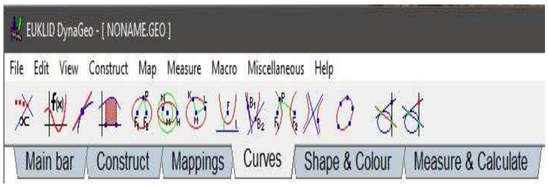
2. Construct:



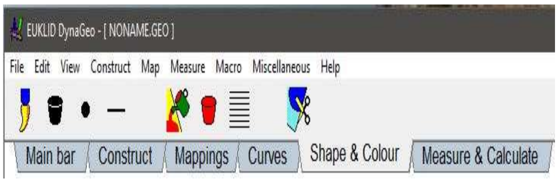
3. Mappings:



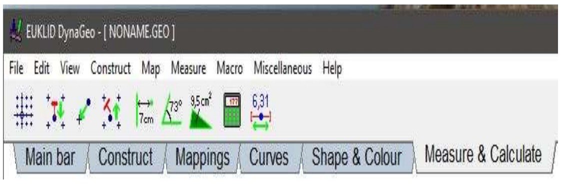
4. Curves:



5. Shape & Colour:



6. Measure & Calculate:



In the next section, three examples are demonstrated how the software toolbars are used in practice.

3. SOME APPLICATIONS

3. 1. Desargues's Theorem

It is well known that the Desargues theorem in projective geometry is:

Two triangles are in perspective centrally if and only if they are in perspective axially.

Let the above triangles are ABC and $A^1B^1C^1$, and they are perspective by the central M. It must be shown that

$$D = AB \cap A^1B^1,$$
$$E = BC \cap B^1C^1,$$
$$F = AC \cap A^1C^1$$

are collinear. The proof is displayed in Figure 1.

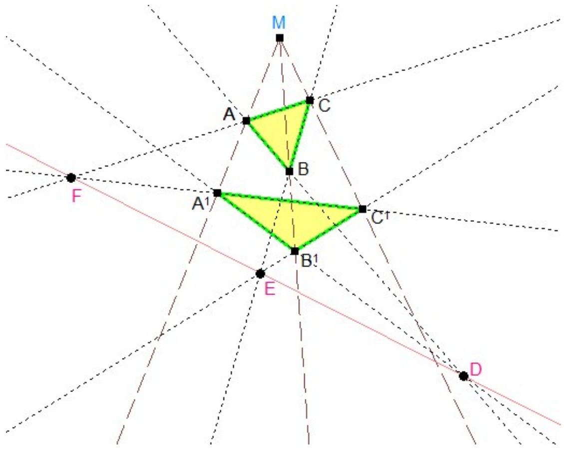


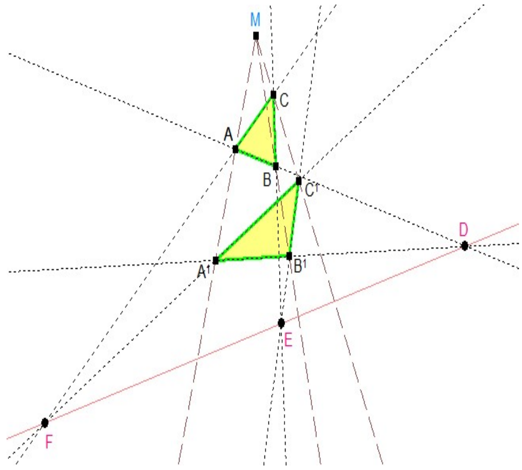
Figure 1. Displayed Desargues Theorem

All the construction steps are in the bookmark with "View >> Show construction text". This command allows users to see, how the construction has been designed, as follows:

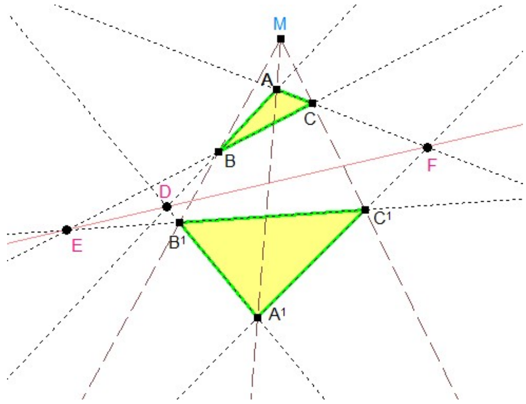
Construction text

M is a free basis point
A is a free basis point
h_1 is a ray starting in point M and running through point A
B is a free basis point
h_2 is a ray starting in point M and running through point B
C is a free basis point
h_3 is a ray starting in point M and running through point C
A^1 is a basis point snapped to h_1.
B^1 is a basis point snapped to h_2.
C^1 is a basis point snapped to h_3.
s_1 is the line segment [A ; B]
s_2 is the line segment [B ; C]
s_3 is the line segment [A ; C]
s_4 is the line segment [A^1 ; B^1]
s_5 is the line segment [B^1 ; C^1]
s_6 is the line segment [A^1 ; C^1]
g_1 is the line (A ; B)
g_2 is the line (A^1 ; B^1)
D is the intersection point of the lines g_2 and g_1
g_3 is the line (C ; B)
g_4 is the line (C^1 ; B^1)
E is the intersection point of the lines g_4 and g_3
g_5 is the line (A ; C)
g_6 is the line (C^1 ; A^1)
F is the intersection point of the lines g_6 and g_5
g_7 is the line (F ; E)
N_1 is the polygon [A ; B ; C].
F_1 is the filling of the area with the border N_1 .
N_2 is the polygon [A^1 ; B^1 ; C^1].
F_2 is the filling of the area with the border N_2 .

To show that geometric construction is always valid, two dragged positions of *Desargues Theorem* are displayed in Figure 2.



(a)



(b)

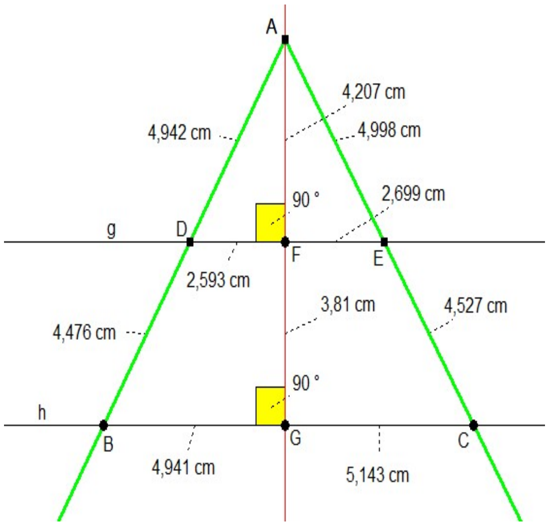
Figure 2. (a), (b), using the drag option for two different positions.

3.2. Demonstration of Similarity Ratios of a Triangle

Let g and h are two parallel lines, and choose a point A that is not on these parallel lines. We draw two different straight lines from A afterward. Let the intersection points with g and h be D, B, E, C, respectively. Finally, there is a similarity ratio between ADE and ABC triangles. Therefore,

$$\frac{|AD|}{|AB|}=\frac{|AE|}{|AC|}=\frac{|DE|}{|BC|}=\frac{|DF|}{|BG|}=\frac{|FE|}{|GC|}=\frac{|AF|}{|FG|}.$$

In Figure 3, this similarity is displayed and all similarity ratios are given.



(a)

d(A;D)/d(A;B) 0,52	d(A;E)/d(A;C) 0,52
d(A;F)/d(A;G) 0,52	d(D;F)/d(B;G) 0,52
d(F;E)/d(G;C) 0,52	d(D;E)/d(B;C) 0,52

(b)

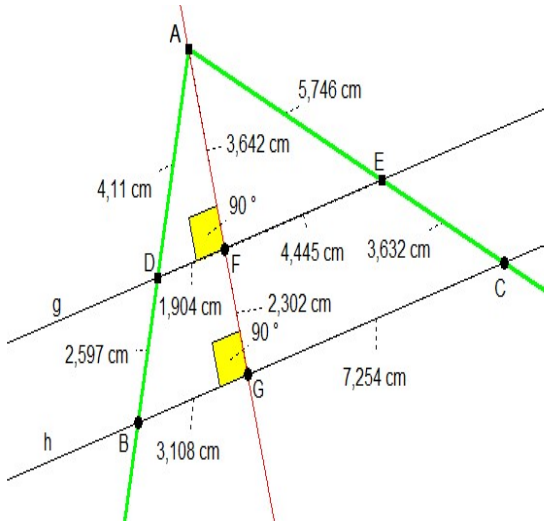
Figure 3. Displayed similarity of a triangle (a) and the related similarity ratios (b).

The similarity construction steps are as follows:

Construction text

- D is a free basis point
- E is a free basis point
- g is the line (D ; E)
- (P_3 is a free basis point)
- h is the parallel to g through P_3
- A is a free basis point
- h_1 is a ray starting in point A and running through point E
- a is a ray starting in point A and running through point D
- B is the intersection point of the lines h and a
- C is the intersection point of the lines h and h_1
- g_3 is the perpendicular of A on h
- F is the intersection point of the lines g_3 and g
- G is the intersection point of the lines g_3 and h
- α_1 is the angle (A ; F ; D)
- α_2 is the angle (A ; G ; B)
- T_4 is the expression d(D;F)/d(B;G).
- T_5 is the expression d(F;E)/d(G;C).
- T_1 is the expression d(A;D)/d(A;B).
- T_2 is the expression d(A;E)/d(A;C).
- T_3 is the expression d(A;F)/d(A;G).
- T_6 is the expression d(D;E)/d(B;C).

To show that geometric construction is always valid, two dragged positions of Similarity Ratios are displayed in Figure 4. and Figure 5.

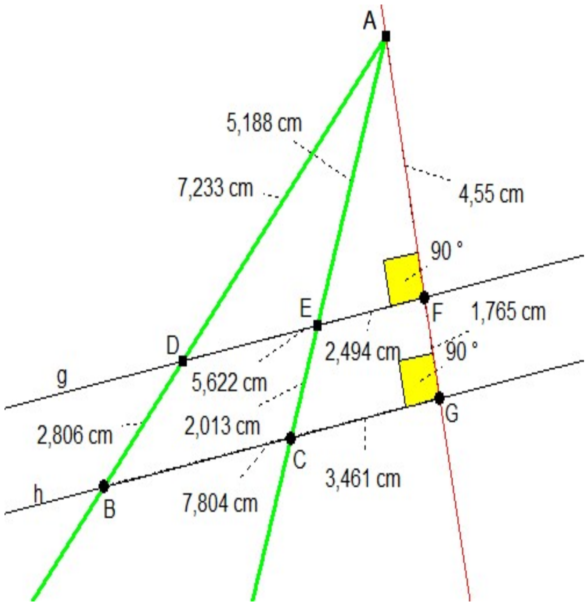


(a)

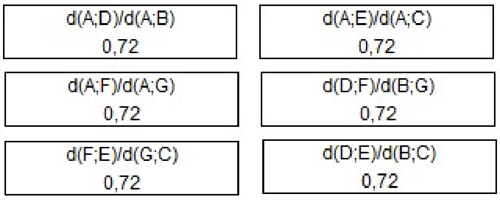
d(A;D)/d(A;B) 0,61	d(A;E)/d(A;C) 0,61
d(A;F)/d(A;G) 0,61	d(D;F)/d(B;G) 0,61
d(F;E)/d(G;C) 0,61	d(D;E)/d(B;C) 0,61

(b)

Figure 4. Using the drag option for a different position (a) and the related similarity ratios (b).



(a)



(b)

Figure 5. Using the drag option for a another position (a) and the related similarity ratios (b).

3.3. Demonstration of Trisectrix

A straight line rotates around O and P, whereby the angle at P is three times as large as the angle at O. The path curve of the intersection S of the two straight lines is the *trisectrix*, which demonstrated in Figure 6.

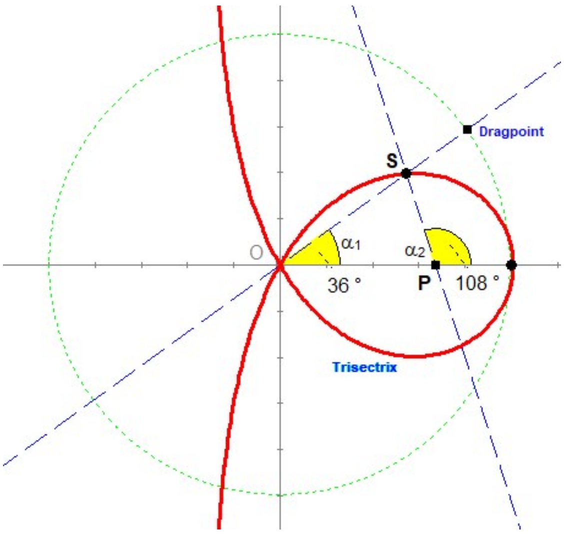
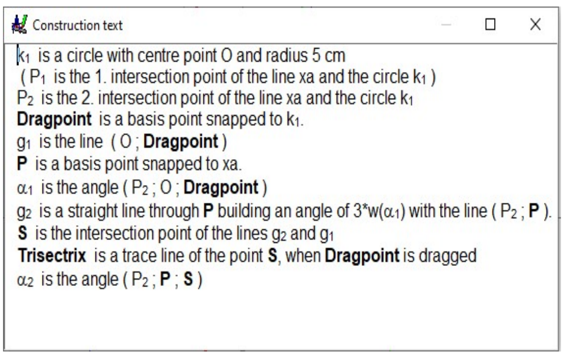


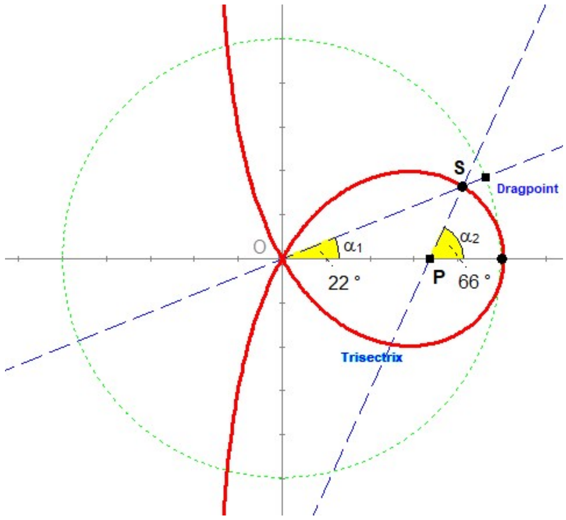
Figure 6. Trisectrix as a path curve.

The trisectrix construction steps are as follows:

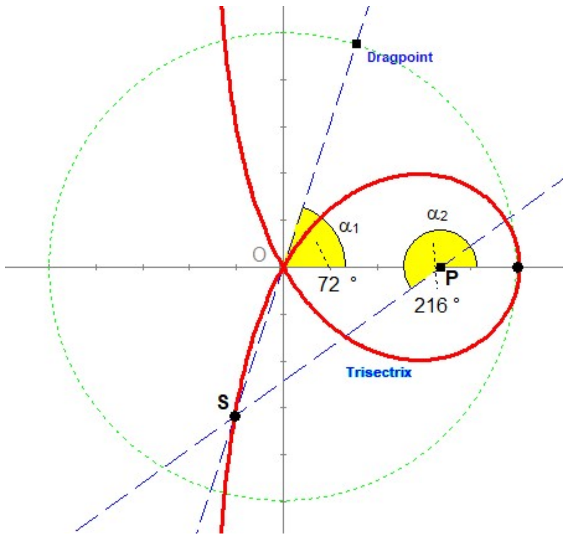

Construction text

k_1 is a circle with centre point O and radius 5 cm
(P_1 is the 1. intersection point of the line xa and the circle k_1)
P_2 is the 2. intersection point of the line xa and the circle k_1
Dragpoint is a basis point snapped to k_1.
g_1 is the line (O ; **Dragpoint**)
P is a basis point snapped to xa.
α_1 is the angle (P_2 ; O ; **Dragpoint**)
g_2 is a straight line through **P** building an angle of 3*w(α_1) with the line (P_2 ; **P**).
S is the intersection point of the lines g_2 and g_1
Trisectrix is a trace line of the point **S**, when **Dragpoint** is dragged
α_2 is the angle (P_2 ; **P** ; **S**)

Two dragged positions of trisectrix are displayed in Figure 7.



(a)



(b)

Figure 7. (a), (b), using the drag option for two different positions of trisectrix.

4. CONCLUSIONS

In this paper, how Euklid DynaGeo serves the users to realize the constructional geometrical drawings is demonstrated.

Moreover, it is clear computer users is getting increased. That means in the future, more computer programs have to use especially in lectures. The proposed software is one of them, which provides users an application solution for the 2D geometric drawings for more creative constructions in plane geometry. Finally, if a construction displayed as proof then with the drag option could be shown that for all positions the construction is valid, which offers the users the possibility to try different positions.

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Research and Publication Ethics-Ethics Committee Approval

Since this study involved a desk review, the author asserts that all procedures contributing to this study comply with the ethical standards of the relevant institutional committees. For this type of study, formal consent is not required.

Conflict of Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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