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Book 5

Mathematics, Informatics and Physics

Volume 10, 2013

RUSE

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The Union of Scientists – Ruse (US – Ruse) organizes publishing of scientific and popular informative literature, and since 1998 – the "Proceedings of the Union of Scientists- Ruse".

BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 10

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BOOK 5

"MATHEMATICS, INFORMATICS AND PHYSICS"

VOLUME 10

This is the jubilee 10-th volume of book 5 Mathematics, Informatics and Physics. The beginning was in Spring, 2001, when the colleagues of the former section Mathematics and Physics decided to start publishing our own book of the Proceedings of the Union of Scientists – Ruse. The first volume included 24 papers. Through the years there have been authors not only from the Angel Kanchev University of Ruse but as well as from universities of Gabrovo, Varna, Veliko Tarnovo and abroad – Russia, Greece and USA.

Since the 6-th volume the preparation and publishing of the papers began to be done in English.

The new 10-th volume of book 5 Mathematics, Informatics and Physics includes papers in Mathematics, Informatics and Information Technologies, Physics and materials from the Scientific Conference 'Information Technologies in Education' (ITE), held at the University of Ruse in November 2012 in the frame of Project 2012-FNSE-02.

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GEOGEBRA IN SCHOOL COURSE IN GEOMETRY

Magdalena Metodieva Petkova

Angel Kanchev University of Ruse

Abstract: *This article provides an incremental approach to integration of mathematical software in teaching future teachers in Mathematics. For this purpose the subject School course in Geometry is selected. The emphasis is on developing and presenting some specific tasks in GeoGebra environment through static and dynamic text, animation, LaTeX formulas and tools - sliders and checkboxes.*

Keywords: GeoGebra, school course in geometry, approach and tasks

INTRODUCTION

The School Course in Geometry (SCG) is a discipline that is studied by students majoring in Mathematics and Informatics in the ***fifth semester*** of their preparation for teachers of mathematics.

The goal of the course is deepening the knowledge of students on a wide range of methods for solving tasks in geometry. The SCG is the basis for teaching disciplines such as ***Methods of Instruction in Mathematics (MIM)***, ***Extracurricular Work in Mathematics (EWM)***, etc.

The curriculum of the course covers the following topics: Logical construction course in geometry; Movements and equality; Figures in the plane; Vectors on the plane and in space; Similarity and homothety; Trigonometric functions of angles; Metrical dependencies in a triangle, polygons and circumferences; Area of figures; Geometrical constructions; Geometrical transformations; Geometry of complex numbers; Parallelism and perpendicularity in the space area; Coordinate method; Bodies in the space area; Volumes; Surface area; Sections [5].

The development includes exemplary elaborated tasks in GeoGebra environment, related to the educational content and in accordance with the curriculum in secondary school.

GeoGebra is a software tool that is used all over the world for creating mathematical constructions and dynamic drawings, which are suitable for application in teaching mathematics to students of different age groups. The positive aspects of the use of GeoGebra, which can be listed, are:

- Expanding and enriching learning environment through the use of interactive methods and strategies of teaching and learning.
- Improvement of the existing static forms of teaching materials and implementation of dynamic (multimedia) developments by integrating image, audio, animation and text.
- Electronic and multimedia teaching materials in the educational process [1, p. 146].

The proposed four basic stages of mastering the knowledge and skills to implement GeoGebra in teaching mathematics are:

- **First (Preparatory) stage.** Formation of interest to software by presenting its characteristics (basic menus, submenus and toolbars) and tasks that require simplified

geometric shapes and structures (in the course ***Mathematical software (MS)*** that is studied by students in ***third semester***).

➢ **Second stage.** Study on application of basic commands by developing a system of examples linked to educational content. Development of simple sample assignments and/or structures with the participation of learners. Presentation of tools ***for advanced learners*.**

➢ **Third stage.** Self-study process and preparation on learning resources by using GeoGebra. Presentation of results to appropriate audiences with an ***Interactive Whiteboard (IWB)*.**

➢ **Fourth stage.** Training on the methods of mathematics teaching and learning, based on GeoGebra software. Application of the knowledge and the skills in real learning process and evaluating the results of specialist [1, p. 147].

The second and third stages shall be presented to the students during their training at SCG and the fourth stage – during the ***Current Pedagogical Practice in Mathematics (CPPM)*** or ***MIM***.

IMPORTANT TERMS (FIGURES 1÷3)

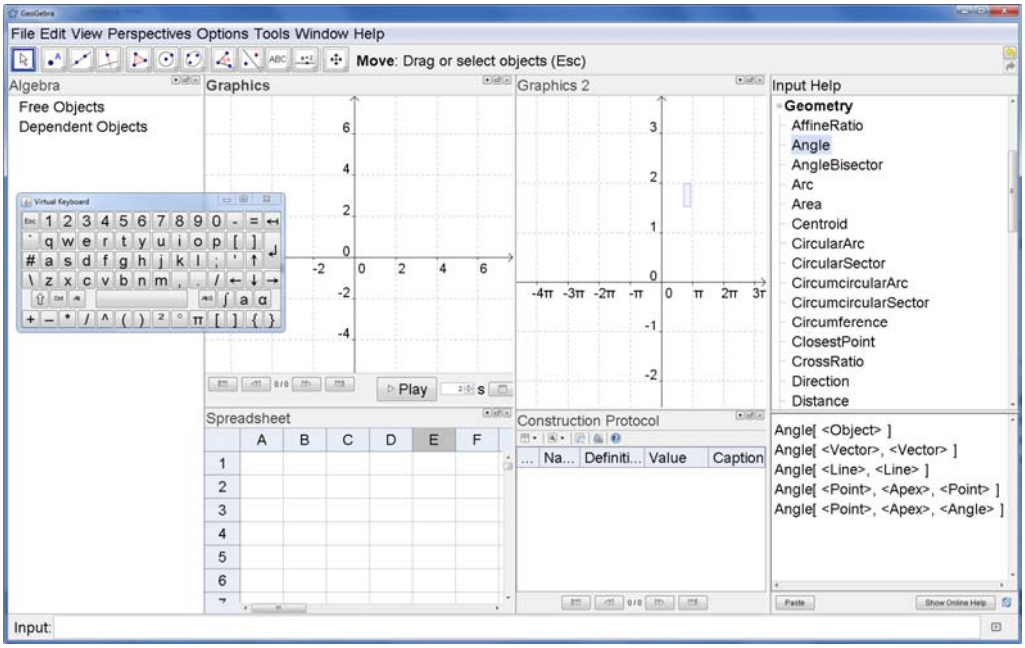

Figure 1: Interface

Figure 2: Toolbars

	***Slider***	Parameter that is changing in a predefined interval
	***Checkbox***	Checkbox for hiding and displaying objects

Figure 3: The tools Slider and Checkbox

THEORETICAL KNOWLEDGE. DEVELOPMENTS

All selected thematic developments are represented through Internet Browser. They have been elaborated in such a way as to provide multi-functional application - in a computer lab, during a presentation, IWB, in an individual work process.

The introduction of mathematical formulas in GeoGebra is performed through **LaTEX.**

What is LaTEX?

LaTEX is a word processing system, widespread in the scientific and academic communities. It is designed for making scientific documentation such as books, articles, dissertations, electronic textbooks in the areas of mathematics, physics, chemistry, engineering and others. LaTEX is using the program **TEX** (established in 1977 by the mathematician **Donald Knuth** for writing texts containing mathematical formulas) as a mechanism for word processing [2, p. iii], [4, p. 1 - 5].

How mathematical formulas in **LaTEX** appear without compiling text visualization?

This command

\frac{a}{b}=\frac{6}{7}

in **LaTEX** is equivalent to the command

$$\frac{a}{b}=\frac{6}{7},$$

or this command

\int{ \frac{4 (cosx)^{2}+3 (sinx)^{2}}{cosx}dx

have the equivalent of

$$\int \frac{4(\cos x)^2+3(\sin x)^2}{\cos x}\,dx.$$

The possibility of using **LaTEX** in the development of mathematical constructions in GeoGebra by students studying mathematics and informatics could contribute to the preparation of high-quality footage for secondary education.

The specifications of each structure are provided in advance.

1. Linear function of an independent variable

The following three examples involve two variables *a* and *b* which change at predefined interval [-50, 50]. This interval can be changed depending on the condition of the task (Figures 4÷6).

The structure includes a color graph, title, two sliders, two input fields of value, dynamic and static text.

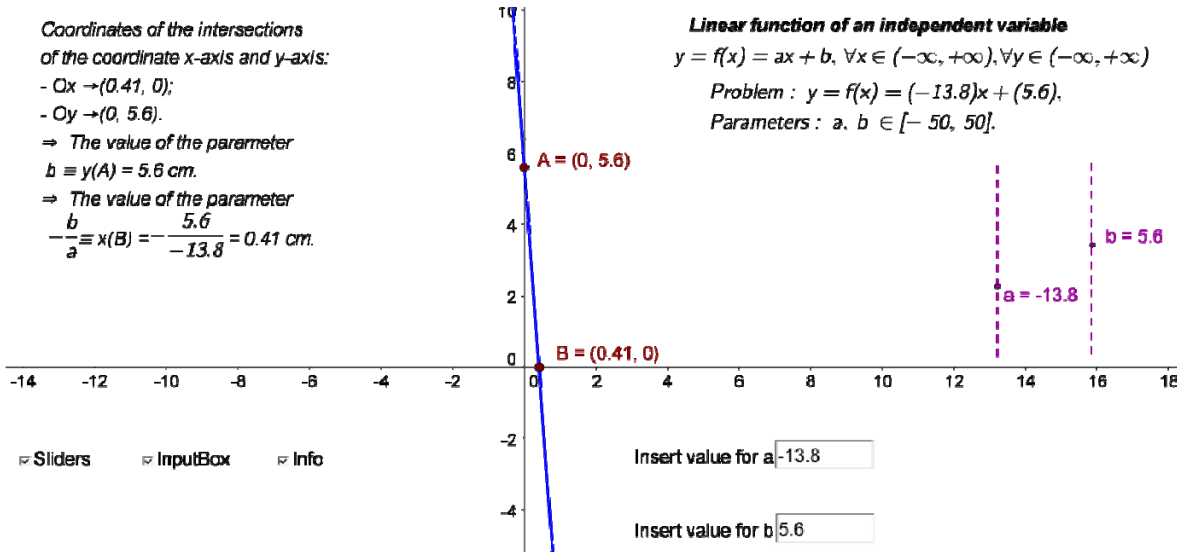

Figure 4: Problem 1

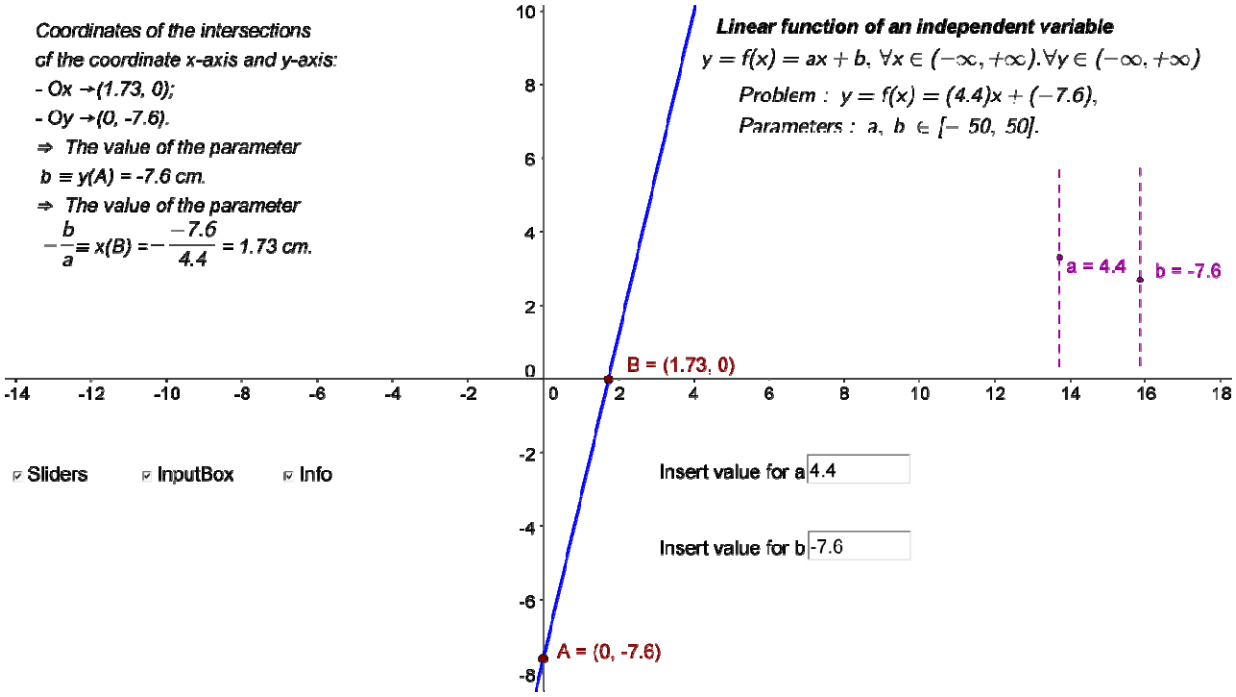

Figure 5: Problem 2

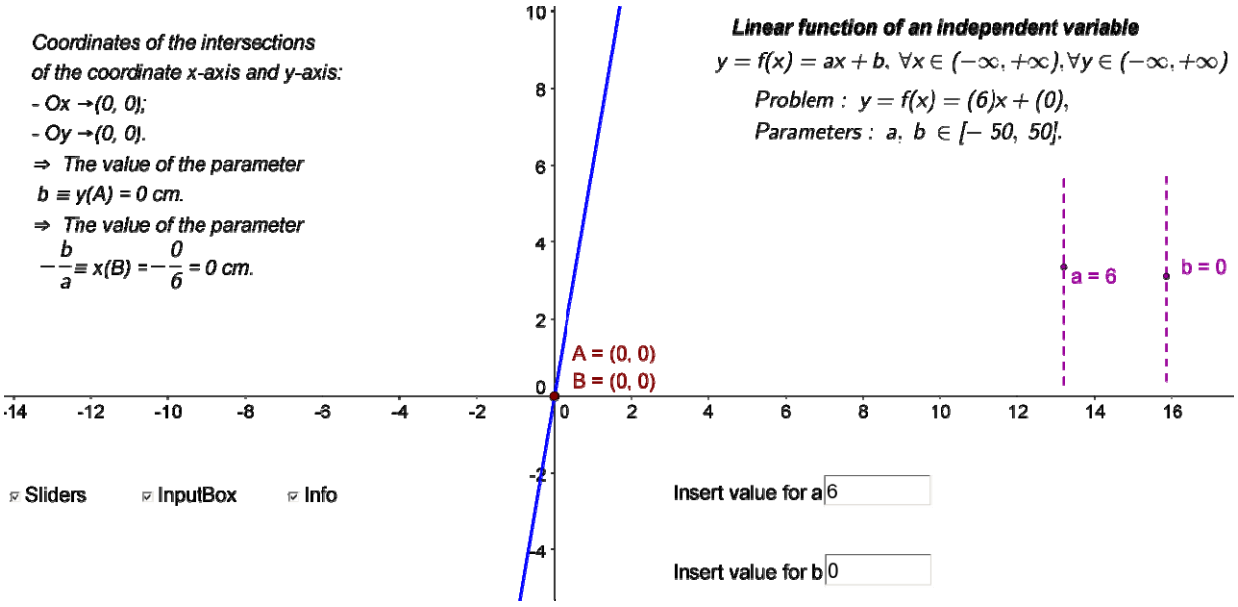

Figure 6: Problem 3

2. *Excircles of a triangle*

The structure includes a basic drawing, dynamic and static text and four sliders.

Construction (Figure 7):

- Construct a random triangle ΔABC.
- Prolong all the sides.
- Construct the three internal bisectors l_a, l_b, l_c.
- Construct the three external bisectors l_a^*, l_b^*, l_c^*.
- The excenters of the excircles are the points O_a, O_b, O_c, obtained by the intersection of the respective internal and external angle bisectors:

$$O_a = l_a \cap l_b^* \cap l_c^*; \quad O_b = l_b \cap l_a^* \cap l_c^*; \quad O_c = l_c \cap l_b^* \cap l_a^*.$$

- Draw the three circumferences, making perpendicular lines from the points O_a, O_b, O_c to the sides of the triangle. These would be the three radii of the three excircles [3, c.94].

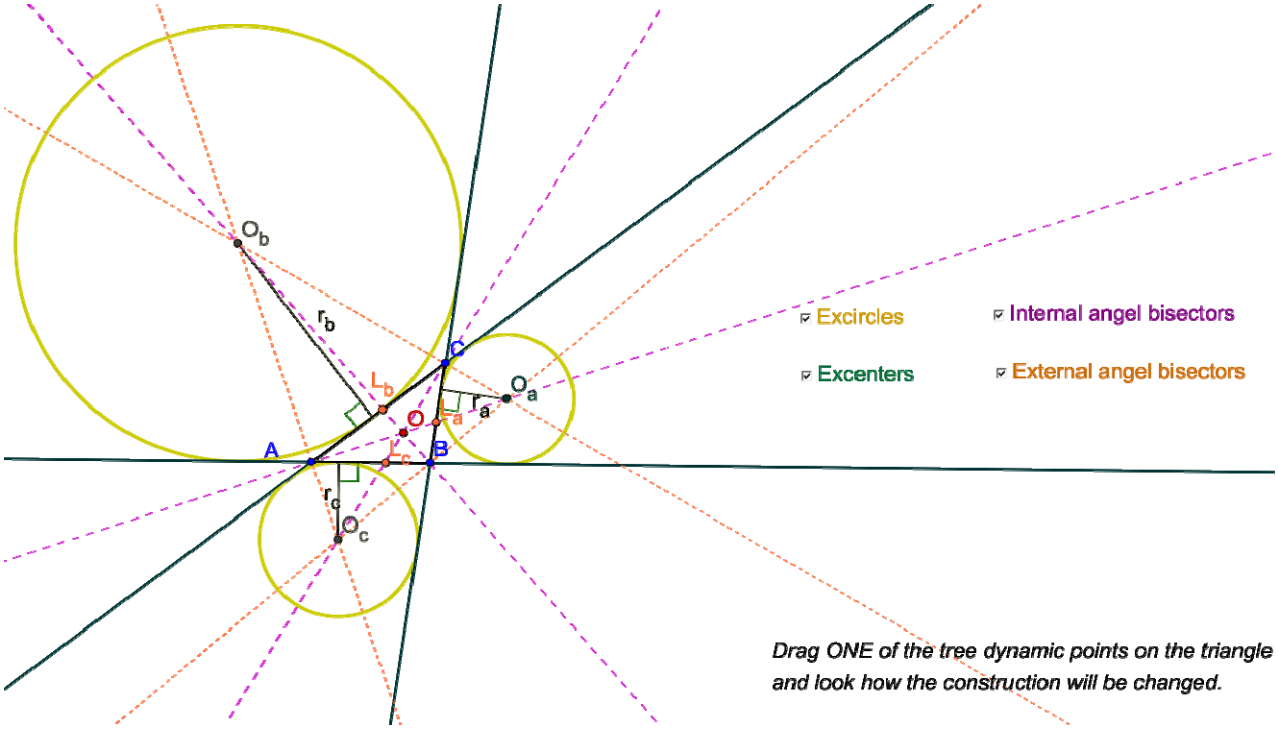

Figure 7: Excircles of a triangle with internal and external angle bisectors

3. Euler line.

The orthocenter, the centroid and the circumcenter of any triangle are aligned (Figure 8÷11). They belong to the same straight line, called ***line of Euler*** [6].

The construction includes drawing, static and dynamic text, four checkboxes.

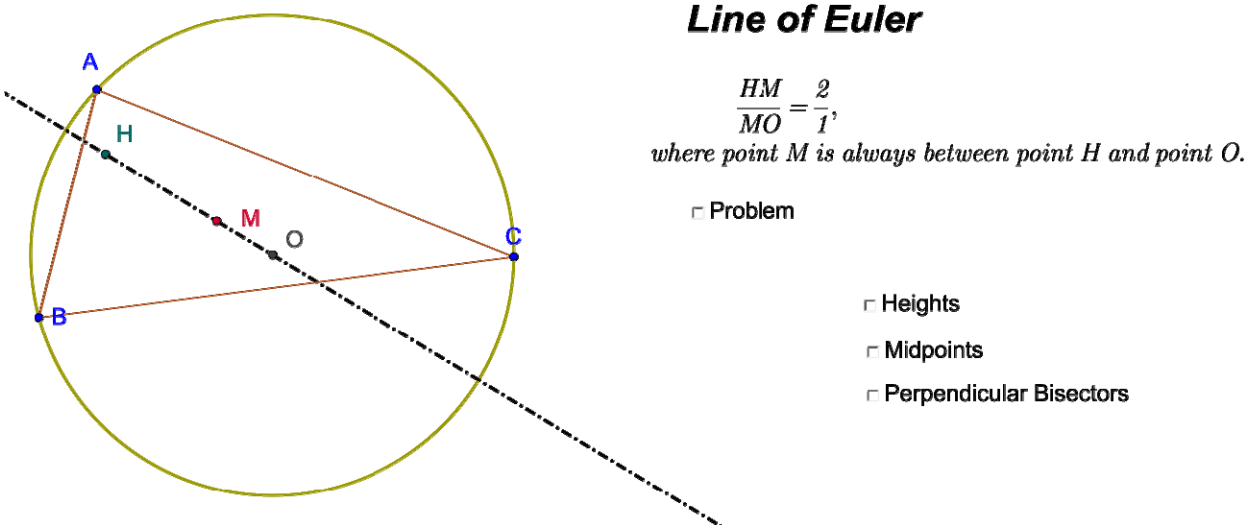

Figure 8: Line of Euler

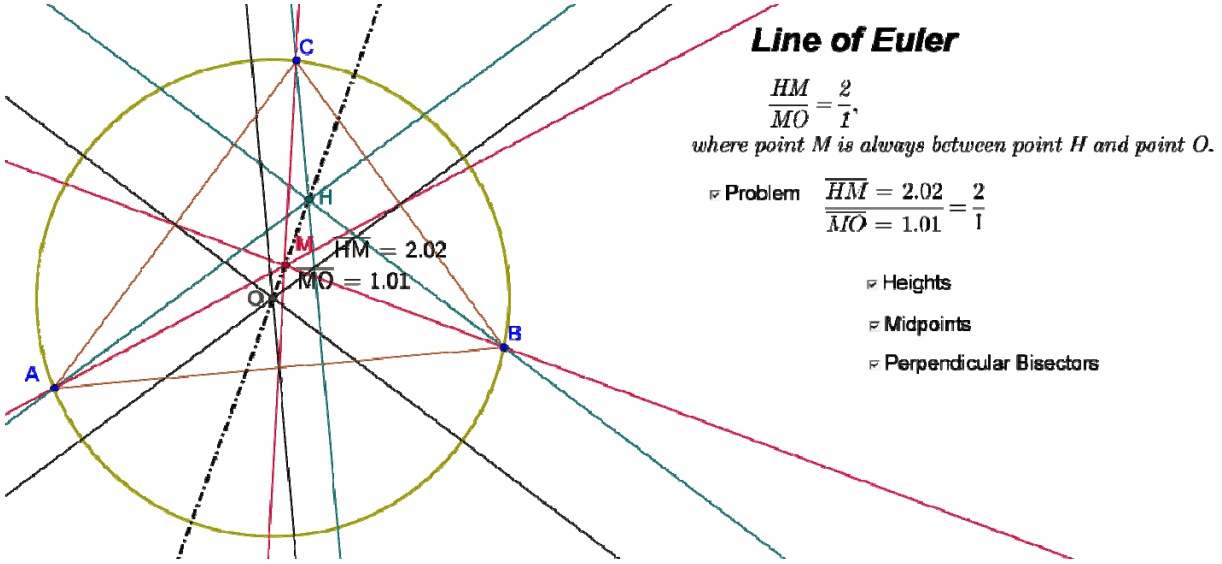

Figure 9: Problem 1 (acute-angled triangle)

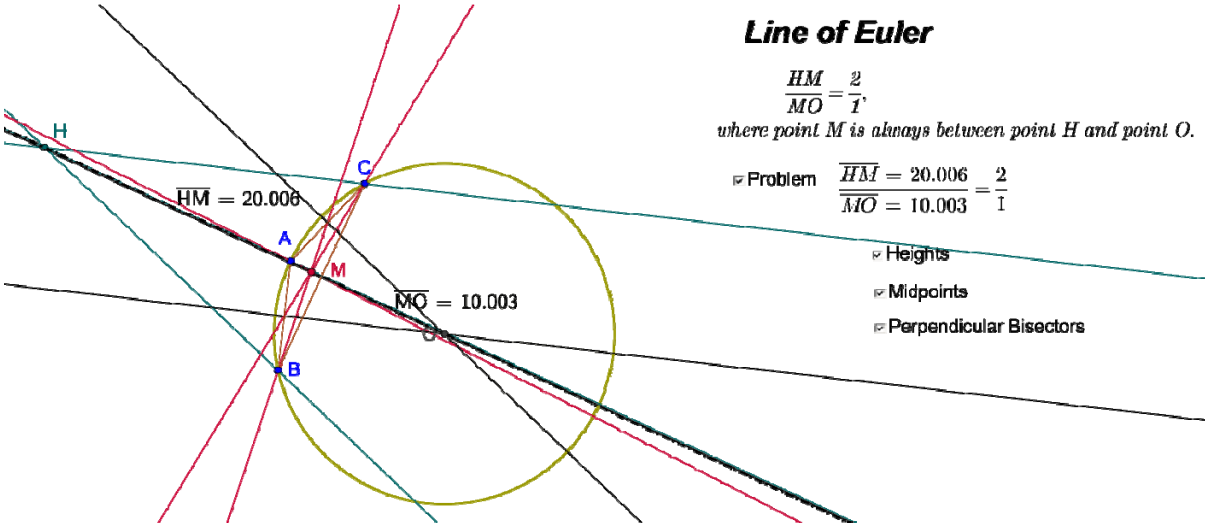

Figure 10: Problem 2 (obtuse-angled triangle)

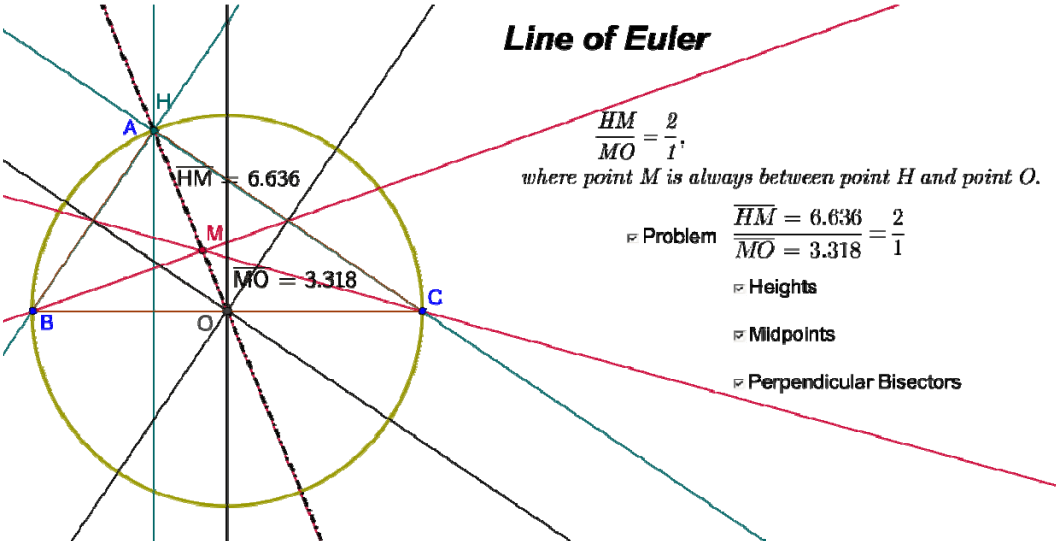

Figure 11: Problem 3 (right triangle)

4. Regular hexagon.

The construction contains a drawing, a slider (parameter), settings to start and stop the animation, static text, and tracking.

Construction (Figure 12 and 13):

- A parameter $r \in [1,25]$ is developed, where r is the length of the radii of all seven circumferences in the figure.
- The first circumference is the center is drawn, which appears central for the construction with a center and a point on it (point B).
- The point B will be the center of the second circumference with radius r.
- The intersections of the first to the second circumference are exactly those points, which are the centers of the next two circumferences with radii equal to r.
- Continue until all new sections are used as centers of circumferences, i.e. there must be six circumferences without central circumference.
- The following settings are additional: add color, insert animation, place trail static text, export to **html** format (suitable for training and implementation in presentations).

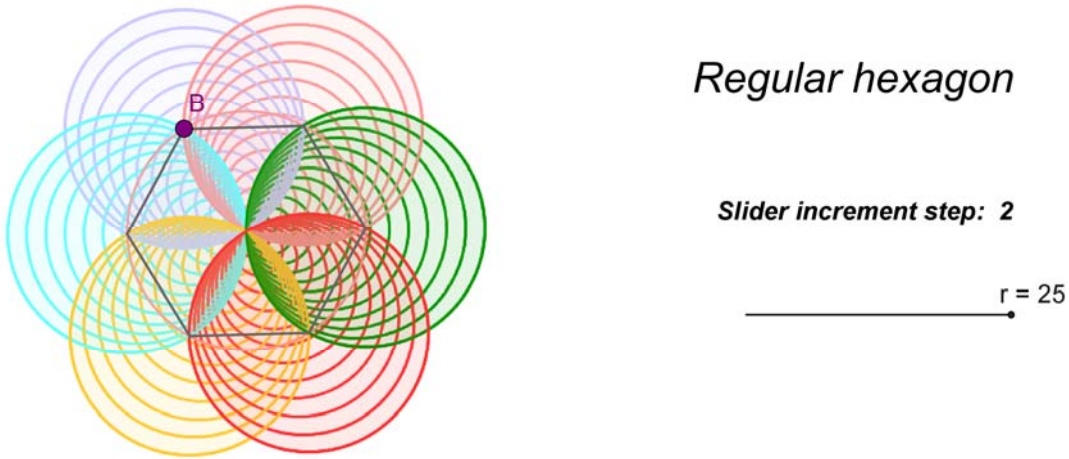

Figure 12: Regular hexagon (slider increment 2.00)

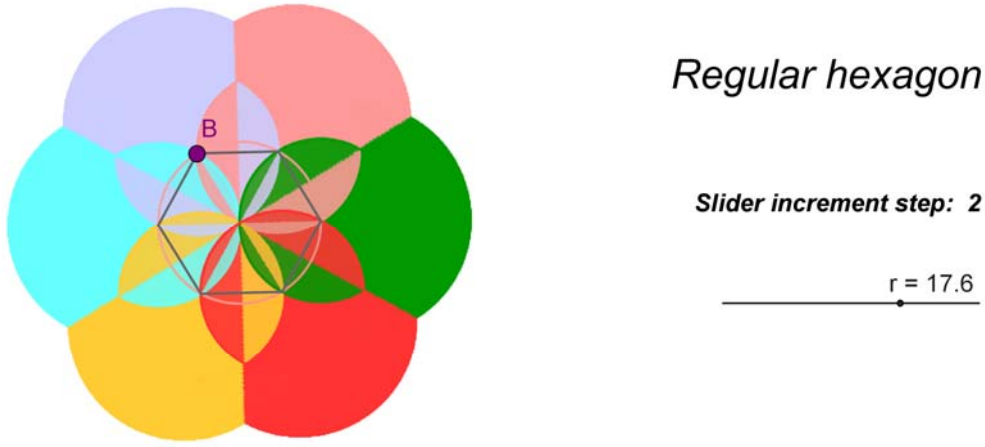

Figure 13: Regular hexagon (slider increment 0.02)

CONCLUSION

Working with software GeoGebra helps to raise the level of teaching mathematics. This software can be modified to the needs of the users (students, teachers, researchers). It is an easy tool for organizing examples of current teaching/ presentation and for complex structures, requiring extensive research in a given area.

The study of GeoGebra in ***SCG*** contributes to the creative development and improvement of future math teachers during their training.

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CONTACT ADDRESS

Assist. Magdalena Petkova, PhD student
Department of Mathematics
Faculty of Natural Science and Education
Angel Kanchev University of Ruse
8 Studentska Str., 7017 Ruse, Bulgaria
E-mail: mpetkova@uni-ruse.bg
magipetkova@gmail.com

GEOGEBRA В УЧИЛИЩНИЯ КУРС ПО ГЕОМЕТРИЯ

Магдалена Методиева Петкова

Русенски университет „Ангел Кънчев"

Резюме: *В тази статия е представен примерен постъпков подход за интегриране на математически софтуерен продукт по време на обучаването на бъдещи учители по математика. За тази цел е избрана дисциплината Училищен курс по геометрия. Акцентирано е върху разработването и представянето на няколко конкретни теоретични постановки в GeoGebra среда чрез статичен и динамичен текст, анимация, LaTeX формули и инструменти - плъзгач, чекбокс (поле за отметка).*

Ключови думи: *GeoGebra, Училищен курс по геометрия, подход и примери*

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