LABORATORY OF MATHEMATICAL MACHINES – 9th GENERAL LYCEUM OF PATRAS (MML9GLP)

During the school year (2017-18), the Laboratory of Mathematical Machines was established, which is the only one in Greece and one of the very few existing in Europe. The idea of the coordinator eventually became a necessity, due to the nature of the activities and the corresponding needs that arose. The original inspiration for the study of this timeless aspect of Mathematics came from Professor of Mathematics Education, Mrs. **Evgenia Koleza**.

Finally, from the school year 2024-25, it acquired its own space thanks to the interest of the principal of the 9th General Lyceum of Patras, Mr. Dimitris Delimaris. More than eighteen (18) artifacts are housed, each offering its own path of analysis, study, simulation, and construction, either by the coordinator or by the students. The machines are accompanied by worksheets for the targeted study of the mechanism and the highlighting of the Mathematics embedded within them.

Important mathematical machines are also hosted in simulation, through the mathematical software GeoGebra, and they constitute a challenge, a goal, and a teaching necessity to be constructed and exhibited for study by students, teachers, and university students.

Figure 1: A van Schooten parabolograph of MML9GLP and related experimental teaching in 2022 at the 9th General Lyceum of Patras **https://www.geogebra.org/m/fafjvqkq**

The history of mathematical machines spans the centuries. They begin from the era of **Hippias, Archytas, Menaechmus, Archimedes, and Hero**, through the age of **da Vinci, Dürer, Galileo, Scheiner, Descartes, Cavalieri, van Schooten, Leibniz, Huygens, and Newton**, reaching **Napier, Perks, Suardi, Sylvester, Kempe, Watt, Chebyshev, Peaucellier, Lipkin, Reuleaux, Abakanowicz, Brown, Gonella, Amsler, Kleri'c, Klein, Tweedie, Kelvin, Curoda, Bush, Yates, Artobolevskii, Freudenstein,** and **Dimarogonas**.

Professor **Spyros Pnevmatikos** and Professor **Evgenia Koleza**, during relevant meetings at the Patras Science Center, emphasized that

> "***their presence historically represents the corresponding era in which they were constructed by a mathematician to address a need, some significant problem***".

Looking now at our students, through the curricula that have been implemented and are still being implemented in Greece, it has not been taught in the last fifty years (at least) how, for

example, the logarithmic-exponential curve or the hyperbolic curve is drawn. Furthermore, no one has wondered whether there exist "tools" (other compasses, according to Descartes) to draw them, and what their fascinating history is… a history that also highlights the corresponding social conditions. Usually, in an abrupt manner, it is mentioned that "***this is the graph of the exponential function,***" and at best, school textbooks provide a "point-by-point" construction of hyperbola. However, the "command" is not even knowledge, and the pointwise approach is approximate knowledge. There is certainly no mention of recognizing whether a curve is a segment of a circle, a parabola, or an ellipse… students, and not only them, are unable to do so. **These questions, however, cannot be answered when CONIC SECTIONS as Geometry, as well as SOLID GEOMETRY, have been or are about to be placed in some Science Museum.**

In all the above, the engagement of students with mathematical machines reduces the huge cognitive gap, without these constituting a "black box" of the approximate technology of computers in related simulations, as well as of the "A.I. mentality." Mathematical machines are constructed in such a way as to embody mathematical concepts and relations, and they highlight significant moments in the history of Mathematics. From a didactic perspective, the process of reverse engineering is of particular importance. The purpose of reverse engineering is to understand how an object, to recreate it, or to create a similar object with additional improvements.

Figure 2: Male and female students process and analyze machines of MML9GLP (CAVALIERI parabolograph)
https://www.geogebra.org/m/rnkttmh9

It constitutes a genuine STEM teaching method that does not stop only at visual and tactile contact with the artifact, the analysis of its materials and joints, and the exploration of the mathematical theorems it conceals. We proceed – as far as possible – the simulation and construction of the mechanism using simple materials (wooden rods, wooden surfaces, special and simple screws and joints). Through this process, students approach Mathematics holistically and within a collaborative STEM environment.

In the last two years, the students of MML9GLP have presented their work during the 1st and 2nd Mathematics Conference of Western Greece, where they submitted relevant articles and

demonstrated the simulations of the laboratory's machines as well as the physical models themselves. In the first article, they presented the analysis and construction ***Peaucellier–Lipkin straight-line mechanism*** (1870). In the second article, they presented the analysis and construction of the ***Scheiner pantograph*** (1631) and the ***J.J. Sylvester plagiograph*** (1870), highlighting the existence of MML9GLP.

Figure 3: The three mathematical machines constructed this year and last year, presented at the Mathematics Conferences of Western Greece, accompanied by relevant articles.

Indicative actions of EMM9GLP:

1. **Experimental teaching in 2019** of MML9GLP with 11th grade classes of **Athens College** at the Patras Science Center, under the supervision of Professor Spyros Pnevmatikos and Professor Evgenia Koleza, where the concept of the parabola was analyzed through the mediation of our first two (2) mathematical machines (Cavalieri & van Schooten).

2. **Experimental teaching in 2022** of MML9GLP at the 9th General Lyceum of Patras through the mediation of the two (2) parabolographs CAVALIERI and VAN SCHOOTEN.
https://edu-gate.minedu.gov.gr/index.php?option=com_content&view=article&id=6132:9&catid=19&Itemid=175

3. **Participation of MML9GLP in the 1st Mathematics Conference of Western Greece** (April 2024) and submission of a relevant article.
http://9lyk-patras.ach.sch.gr/2024/05/17/article/

4. **Experimental teaching of MML9GLP at the 6th Gymnasium of Patras** to a group of middle school students.
(A) http://9lyk-patras.ach.sch.gr/2024/04/27/announcement-of-laboratory-of-mathematical-machines-9th-gel-of-patras/

(B) http://9lyk-patras.ach.sch.gr/2024/06/30/the-9th-lyceum-of-patras-in-the-press/

5. **Participation of MML9GLP in the 2nd Mathematics Conference of Western Greece** (April 2024) and submission of a relevant article.

(A) http://9lyk-patras.ach.sch.gr/2025/03/17/press-release-2/

(B) http://9lyk-patras.ach.sch.gr/2025/02/20/article-from-the-mathematical-machines-laboratory/

6. **Panhellenic School Network:**

(A) https://www.sch.gr/deltio-typou-to-gymnasio-ovryas-patron-sto-ergastirio-mathimatikon-michanon-9ou-gel-patras-13_02_2026/

(B) https://www.sch.gr/to-6o-gymnasio-patron-sto-ergastirio-mathimatikon-michanon-9ou-gel-patras-12_03_2026/

(C) https://www.sch.gr/arthra-mathiton-kai-mathitrion-tou-emm9glp-gia-to-1o-2o-mathimatiko-synedrio-dytikis-ellados-2024-2025/

(D) https://www.sch.gr/syntomi-istoria-kai-prosomoiosi-sto-geogebra-ton-paravolografon-diaviton-charaksis-paravolikon-tokson-apo-to-ergastirio-mathimatikon-michanon-tou-9ou-gel-patras/

(E) https://www.sch.gr/to-1o-gel-patras-sto-ergastirio-mathimatikon-michanon-tou-9ou-gel-patras-emm9glp/

(F) https://www.sch.gr/ergastirio-mathimatikon-michanon-9ou-gel-patras/

7. **Invitation from MML9GLP to all Gymnasiums and Lyceums** for conducting experimental teachings.

http://9lyk-patras.ach.sch.gr/2025/12/06/%ce%b5%cf%81%ce%b3%ce%b1%cf%83%cf%84%ce%ae%cf%81%ce%b9%ce%bf-%ce%bc%ce%b1%ce%b8%ce%b7%ce%bc%ce%b1%cf%84%ce%b9%ce%ba%cf%8e%ce%bd-%ce%bc%ce%b7%cf%87%ce%b1%ce%bd%cf%8e%ce%bd-9%ce%bf%cf%85-%ce%b3%ce%b5-2/

8. **Experimental teaching at MML9GLP with a group of students from the Gymnasium of Ovrya, Patras**

http://9lyk-patras.ach.sch.gr/2026/02/18/%ce%b4%ce%b5%ce%bb%cf%84%ce%b9%ce%bf-%cf%84%cf%85%cf%80%ce%bf%cf%85-13_02_2026-%ce%b3%cf%85%ce%bc%ce%bd%ce%ac%cf%83%ce%b9%ce%bf-%ce%bf%ce%b2%cf%81%cf%85%ce%b1%cf%83-%cf%80%ce%ac%cf%84%cf%81%ce%b1/

9. **Experimental teaching sessions at MML9GLP with groups of students from the 12th General Lyceum of Patras.**

(A) http://9lyk-patras.ach.sch.gr/2026/01/24/%ce%b4%ce%b5%ce%bb%cf%84%ce%af%ce%bf-%cf%84%cf%8d%cf%80%ce%bf%cf%85-23-1-2026/

(B) http://9lyk-patras.ach.sch.gr/2026/01/19/%ce%b4%ce%b5%ce%bb%cf%84%ce%af%ce%bf-%cf%84%cf%8d%cf%80%ce%bf%cf%85-16-1-2026/

(C) http://9lyk-patras.ach.sch.gr/2026/01/15/%ce%b4%ce%b5%ce%bb%cf%84%ce%af%ce%bf-%cf%84%cf%8d%cf%80%ce%bf%cf%85-9-1-2026/

10. Experimental teaching sessions at MML9GLP with a group of students from the 1st General Lyceum of Patras.

(A) https://blogs.sch.gr/gkdodos/2026/03/17/to-1o-gel-patras-sto-emm9glp-13-3-2026/

(B) https://www.sch.gr/to-1o-gel-patras-sto-ergastirio-mathimatikon-michanon-tou-9ou-gel-patras-emm9glp/

11. Experimental teaching with a group of students from the 6th Gymnasium of Patras at MML9GLP.

(A) https://blogs.sch.gr/gkdodos/2026/03/16/deltio-typoy-to-6o-gymnasio-patras-sto-emm9glp-12-3-2026/

(B) https://6gympat.blogspot.com/2026/03/6-9.html

(C) https://6gympat.blogspot.com/2026/03/blog-post_26.html

(D) https://www.sch.gr/to-6o-gymnasio-patron-sto-ergastirio-mathimatikon-michanon-9ou-gel-patras-12_03_2026/

12. Edu-Gate (Ministry of Education) & Laboratory of Mathematical Machines of the 9th General Lyceum of Patras

https://blogs.sch.gr/gkdodos/2025/11/07/edu-gate-ypaitha-amp-amp-ergastirio-mathimatikon-michanon-9oy-gel-patras/

The coordinator of MML9GLP

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