The Introduction of European Mathematics in Greek Intellectual World During the 18th Century

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Abstract. A characteristic of the centuries following the conquest of Constantinople was a diminished interest in pure sciences and the domination of the scholasticism. During this time, mathematical education of Greeks is limited to the study of simple arithmetic manuals. At the end of the 17th century, the Ottoman Empire tried to be in harmony with the new political European climate, granting special privileges to the enslaved Greeks, who, finally managed to take under control trade and diplomatic affairs. The formation of the social group of traders, the improvement of the status of the Phanariotes and their ascent into power at the Danube Principalities, had as an outcome the introduction of new ideas and an improvement of intellectual consciousness among enslaved Greeks. Several scholars studied in European institutions and after coming back, they brought with them the newly acquired knowledge. During the first decades, the Italian universities (Padova and Pisa) were preferred and later on the German speaking ones (Vienna, Halle, and Göttingen). That is to say, that the traders and the Greek scholars who studied the "*sciences*" in Europe became the channel of the gradual introduction of scientific thought in general and mathematical thought in particular in the Greek intellectual world.

As an introduction, we consider it necessary to present a brief outline of the scientific European scene during the 18th century [1-10]. In Europe, the 18th century was a period of intellectual, social, and political ferment. This time is often referred to as the age of Enlightenment, for it was in the 18th century that the ideas of the previous 100 years were implemented on a broad scale. Politically, the ideas of John Locke, Thomas Hobbes and others would give rise to a notion of democracy. It would ultimately supplant the monarchical power structure on the European continent. By the end of the century, Adam Smith's economic ideas would provide the intellectual basis for the modern development of capitalism.

The Enlightenment, the American and French revolutions and the economic development of contemporary Europe created the right conditions for the emergence of new theories in the mathematical and natural sciences. Europe became the centre of scientific development, and the 18th century was heavily influenced by the scientific thinking and a view of the world almost exclusively through the scientific lens. For the first time, science became a central piece of public discourse. Until then, much of what is now considered scientific inquiry was pursued by a relatively small group of academics, whose writings did not enjoy widespread circulation. Beginning in the late 17th century, there was a twofold development in academia that would bring about a rapid democratization of scientific knowledge. The first was the foundation of the Paris Academy (1666) and the Royal Society of London (1662), two institutions whose primary purpose was to do scientific research and report their conclusions to the public. Over the next decades, several other institutions were founded on the model of these two, including the Berlin Academy (1700), the St. Petersburg Academy (1724), the Turin Society, and many others.

The second major development in academic life was the rise of scientific journals. These publications were often produced by the academies themselves (e.g., London's *Philosophical Transactions* (1665*)* and Paris's *Mémoires*), though a fair number were

produced independently (e.g., the Acta Eruditorum and Crelle's Journal). These new journals circulated to a wide audience that included many readers outside the scientific community. In one sense, these could be considered among the first "*popular science*" magazines, in that scientific results were reported to an audience of non-specialists. As such, the 18th century was a time when scientific tracts could become bestsellers. One of Euler's books, *Lettres à une princesse d' Allemagne* (*Letters to a German Princess*), went through thirty-eight printings in nine languages and remained in print for a century. At the same time, the circulation of printed books expanded and scientific production escaped from closed circles of scientists, spreading to wider social strata.

Mathematics became the tool for the quantitative description of laws and measures. Its hitherto theoretical and abstract framework, through the development of new probative and descriptive methods, opened the way to the introduction of mathematical formalism. Mathematical productivity focussed on the relatively new fields of calculus and found application in mechanics. By the middle of the 18th century, the scientific revolution was in full swing; decades of research had been compiled, exchanged, corroborated, and communicated to the public.

Some of the most important mathematicians of the 18th century as we all know are the following: Euler, the most prolific mathematician and scientist of the time [11], brothers Jakob and Johann Bernoulli, A. de Moivre, J. Taylor, Ch. Wolff, J. Stirling, C. McLaurin, J. d' Alembert, J. Landen, P. S. Laplace and J. L. Lagrange. Here, we must note that apart from the scientists mentioned above, there were some minor mathematicians, whose mathematical textbooks were translated into Greek language, were taught in Greek schools and really influenced the Greek scholars' work and the educational procedure. These are Octaviano Cammett, Nicolas Louis de Lacaille (1713 – 1762), Georg Ignat L.B. de Metzburg, Johan Andreas von Segner (1704 – 1777) and Guido Grandi (1671 – 1742). In this list, we should add Alexis Claude de Clairaut (1713 – 1765) the French, not minor, mathematician, linked to the philosophers of the Enlightenment.

The new scientific spirit now prevailing in Europe was to exert an influence on the Greek nation, as lines of communication were developed during this period, permitting the dissemination of European scientific and philosophical thought.

Now, it is time to return to the situation in Greek intellectual world starting, however, from the 15th century. The fall of the Byzantine Empire was followed in the Greek world by about two and a half centuries whose main feature was sterile scholasticism and the decline of the sciences. During these centuries, Greek mathematical education was secured by Byzantine logistic manuals, by Emmanuel Glyzonios *Arithmetic* (20 editions from 1568 (Venice) to 1823) [12] and simple mathematical textbooks [13].

The sciences became a marginal part of the curriculum as the Ottoman rule discouraged the diffusion of any contemporary theory and the Patriarchate remained staunchly faithful to theology and grammar as the only appropriate sources of education [13]. Twelve anonymous Arithmetic manuscripts have been recorded up to and including the 17th century, 12 anonymous manuscripts containing elements of Euclidean Geometry and two with excerpts from works by Euclid, Proclus, Psellos and Nicomachos Gerasinos [14].

Of course, this situation arose from and was sustained by the particular circumstances of Hellenism, which not only did stimulate interest in modern scientific thinking but even caused the isolation of the Greek nation from Europe. Thus, at the beginning of the 18th century, with rare exceptions (Sougdouris, Papavassileiou, Notaras), scholars had almost no scientific education.

From the late 17th century, the Ottoman Empire, in its attempt to adjust to the new political climate developing in Europe, awarded privileges to the enslaved Greeks, who were eventually able to control trade and diplomacy to a great extent. The creation of the commercial class, the development of the Phanariot class and their rise to the rule of the Danube Hegemonies, resulted in the creation of novel views and a new intellectual awareness among the Greeks. The realization of the gap separating them from the West acted positively, facilitating the development of the educational process and scientific and philosophical thought in Greece. More and more social classes realised that, from now on, society would improve only through the knowledge arising from a systematic education and practice of the sciences and not through an empirical relationship with matters, which was no longer considered sufficient. Furthermore, this would entail a significant commercial and economic improvement. The number of scholars studying in the West increased substantially. The main places of study were the Italian universities, especially those of Padua and Pisa, and during the last decades prior to the Greek Revolution of 1821 French and German or German-speaking universities (Vienna, Halle, and Göttingen). On completing their studies, many scholars returned home bringing with them this new scientific knowledge.

From the first decades of the 18th century, efforts began for the foundation of schools and libraries, and the translation or writing and publication of mathematics textbooks to serve primarily educational needs. Education was now organised, as it had not been earlier, and the expanding commercial class was the most important social body for the cultivation of letters. Educators were no longer sought in ecclesiastical circles alone, and the proposed education began to specialise. Throughout the long post-Byzantine decline of sciences, mathematics, as we have said, was directly connected only to daily practice, mainly serving commercial needs. The term "*Logariastiki*" (*counting*), used for all the arithmetic textbooks in circulation, is indicative. This attitude had not been completely eliminated even in the 18th century.

The revival, however, of scientific and philosophical thought in the pre-revolutionary century, even though slowly in its first half of the latter generally upgraded the role of the sciences. Mathematics, in particular, gained the dominant position and scholars now believed mathematics to be the "*first of all sciences*" and the foundation of all others [15-16].

Another indication of the interest in mathematics, especially during the last pre-revolutionary decades, are the frequent publications in the contemporary periodical *Logios Hermes* [17-18] of theoretical texts on the science of mathematics – often serialised – reviews of Greek and European mathematical publications, and analytical critical presentation of mathematical textbooks.

Here, we can see the titles of three mathematics textbooks of that time.

During this second period, at first seemingly contradictory, trends formed among scholars. Briefly, these can be referred to as the "*traditional*" and the "*modernist*". The former was based on the conviction that through studying the ancient texts, Greeks would be able to comprehend the unbroken nature of their heritage; the latter rested on the belief that only the "*lights*" of Europe could promote knowledge and therefore instil the necessary self-knowledge in the enslaved Greek nation. The differences between these two trends are far more evident in the natural sciences than in mathematics. This is due to the nature of mathematical science, which is not the most appropriate area for the confrontation of ideas and does not offer itself to popularisation as much as the other sciences. There was a third, intermediate trend represented by the scholars who, although they adopted reformatory European views, attempted to combine the Western spirit with the Greek mathematical heritage.

A characteristic feature of traditionalist scholars, at least the great teachers who forged the spirit of Greek mathematical teaching (Anthracitis, Notaras, Voulgaris, and Theotokis), is that they studied at Italian universities. Italy was a country with a humanist educational system, where the Enlightenment was late to arrive and where ancient authors were systematically taught. On the contrary, in France and Central Europe new mathematics and new physics overshadowed, from the beginning of the century, the ancient Greek sciences. The way these traditionalist scholars handled the science of mathematics created a strong mathematical setting for the 18th century Hellenism. Mathematics may not have been transmitted to the general public, but a significant number of mathematics teachers emerged.

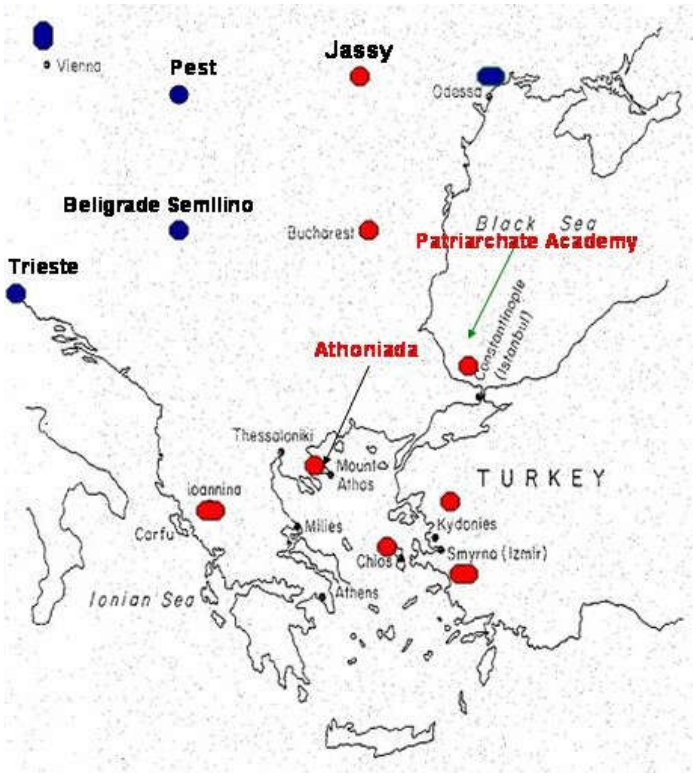
The scholars of the modernist trend studied mostly in Central Europe, at the universities of Iéna, Leipzig, Göttingen and especially Vienna, which from the end of the 18th century was the centre for the propagation of Enlightenment ideas and their dissemination to the East. Here, we should mention that many of the scholars of the period immediately preceding the Greek Revolution, most of whom were modernists, lived for a time, studied in Germany or German-speaking countries or encountered German thought and education. The reasons that originally led them in this direction were "*non-intellectual*", such as commerce with continental Europe after the Treaty of Kutcuk Kainartzi (1774), the foundation of Greek communities in Vienna etc. The view prevailed that nowhere in the world were the natural sciences and philosophy taught more methodically than in German universities [19-20]. Part of this general trend to German education at the end of the 18th and especially at the beginning of the 19th century, was the inclination of Greek scholars to translate German texts, including many mathematical writings (Mathematicaeien usum Tironum Constriptae (Metzburg), *Vollstandige Anleitung zur Algebra* (Euler), *Des freyherum von Metzburg ... Arithmetik und Algebra*). There was a similar trend towards French education, particularly after the fall of the Venetian Republic in 1797, with the corresponding translation of French mathematical textbooks [*Elementa geometricae Euclidis* (Oct. Cammett), *Lecons elementaires des Mathematiques* (M. Abbe de la Caille), *Tractatus Analyticus de Sectionibus Conicis* (M. Abbe de la Caille), *Elementa geometriae planae et solidae* (A. Tacqet)].

In the field of mathematics, the traditional viewpoint was based on the attempt to revive ancient Greek mathematics. The modernist side was based, according to some of its

proponents, on the transmission of new mathematical theories developing in the West. According to others, the modernist side was based on the writing and translation, as far as possible, of simplified texts easily accessible to the general reading public and usable as simple teaching textbooks. Here it must be noted that the scientific work done at this time, in the field of mathematics at least, was via educational rather than research processes. Education was the basic method of introducing mathematical thought to the contemporary Greek-speaking world.

Many schools are believed to have operated during the Ottoman rule. Matthaios Paranikas notes the existence of about 95 schools [21], while Tryphon Evangelidis mentions over 300 [22]. They obviously mean elementary schools, with secondary schools after the 17th century. However, these figures are excessive for the period, and although the word "*school*" does not imply the modern institution, their duration of operation, number of pupils and number of teachers are all subject to further investigation.

Concerning sciences in general and mathematics in particular, the schools of Ioannina were surely the first cradle of their remediation. As early as the late 17th century, Papavassileiou was teaching mathematics from his textbook *Mathematical Course (Mathematike Hodos*). Ioannis Sougdouris, Methodios Anthrakitis, Balanos Vasilopoulos, and later, Eugenios Voulgaris and Kosmas Balanos were among the first to stress the teaching of "*scientific subjects*". Several noteworthy textbooks were taught, whose contents, however, were restricted to traditional mathematics. From the end of the century, when the intellectual life of the country was transferred to regional Greek communities, a turning point in education was observed in the town of Ioannina [23].



The Patriarchal Academy in Constantinople (Megali tou Genous Sxoli) played the longest and certainly one of the most important parts in the history of Greek education [24]. The "*Athoniada*" (Athonite School, School of Mount Athos) at Vatopedi was a school of much shorter life but equally significant [25]. Both these schools were founded by the Patriarchate and always operated under its supervision. Until the middle of the 18th century, the teaching was mainly "*traditional*". It was Eugenios Voulgaris [26], who introduced mathematics to these schools. From 1753 to 1759 Voulgaris was appointed director of the Athonite School, and temporarily (1759 – 1761) headed the Patriarchal Academy.

Other principal teachers were N. Zerzoulis, D. Proios, St. Dougas and K. Koumas. The most fertile period for the Academy was the time from 1804, when D. Proios became headmaster to the start of the Revolution [21, p. 31]. This was a time when, despite continuing adherence to tradition and the survival of the conservative spirit, the arrival of important scholars brought about significant progress in the field of sciences. Noteworthy schools also operated in the regions of Thessaly, the Peloponnese, Agrapha, Athens, Kozani and the Aegean islands. Mathematics was taught in all of these except the School of Patmos, which, despite being one of the best schools in the area of "*letters*", never escaped traditional education [13, p. 77-83; 91-99].

The existing internal autonomy, the Phanariots' rise to power and the development of transit trade are the reasons for a notable intellectual flowering in the areas of regional Hellenism, especially the Istrian hegemonies in the last decades of the pre-revolutionary period. The development of education in the two hegemonic Academies, Bucarest and Iasio attained particularly high levels for the time. The scientific education provided was proportionate, and dominated by the personalities of N. Theotokis, Benjamin Lesvios, L. Photiadis, I. Moisiodax, N Zerzoulis, St. Dougas, D. Govdelas, K. Vardalachos and M. Eliadis [27].

In the other schools of emigrant Hellenism, i.e. those of Odessa, Pest, Vienna, Trieste etc., the sciences did not share the same fate, since the aims of the education provided were completely different to those in the schools of Ottoman-occupied Hellenism. The ultimate aim of education was teaching the Greek language, reinforcing religious ideology and preparing youths for a life in commerce. In this framework, "*scientific*" subjects naturally were marginalised [28; 21, p. 137].

Towards the end of the 18th century and the beginning of the next, through the trend of the Neohellenic Enlightenment [29-30], the so-called "*modernist schools*" were created. These were the Gymnasium of Chios, the Academy of Cydonia and the Philological Gymnasium of Smyrna, in which the teaching of sciences predominated and whose models were, where possible, European. For the Gymnasium of Smyrna we have the first written testimony of the introduction and teaching of modern mathematics (it means the teaching of calculus) by K. Koumas [31]. The principal contributors to the whole enterprise were the scholars Benjamin Lesvios, Th. Kairis, K. Koumas and St. Economos, who managed to make these schools important centres of attraction of pupils and remediation of the natural and mathematical sciences, thereby shaping the new course of Greek education [32-33]. As to the mathematical textbooks published during this period, 28 titles circulated of which many were in two to four volumes. Furthermore, the number of 18th and early 19th century manuscripts recorded to date is 155 eponymous and 94 anonymous texts [14].

In conclusion, after the long decline of the post-Byzantine centuries, both "*letters*" and sciences began to flourish again among Ottoman-occupied Hellenism through the agencies of education, which were, however, to be interrupted to a great extent by the beginning of the Greek Revolution. Regarding mathematics, they were to form part of the wider branch of philosophy and be taught in most of the created schools. Up to the 1740s, Anthrakitis' traditional mathematics represented the peak of modern Greek mathematical education.

Voulgaris was the first to promote reform of its content, followed by Theotokis as the first true representative of Western education. As the decades passed and with the development of the movement of the Neohellenic Enlightenment, the role of education became paramount, with the ultimate aim of the enlightenment of the Greek nation through the dissemination of ever increasing scientific knowledge and the development of critical thinking. Within this framework, the teaching of the natural sciences and mathematics was promoted particularly in the areas of regional Hellenism, i.e. the Istrian hegemonies and the modernist schools on the coasts of Asia Minor. During this period, algebra would become equal to arithmetic and geometry in educational syllabuses, and calculus would be introduced as a taught subject.

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12. Emmanuel Glyzonios or Glyzounis (1530 – 1596) from the island of Chios studied medicine and letters in Italy. In Venice, where later, he was established, provided manuscripts for the King of Spain, Philip II. His *Arithmetic* was the passe partout, which covered the daily needs of the people.
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26. Eugenios Voulgaris (1716, Corfu – 1806, St. Petersburg) one of the greatest exponents of the Neohellenic Enlightenment and "*Teacher of the nation*". He studied in Ioannina and later in Padua of Italy. He was an eminent theologian, mathematician and scholar, and Archbishop of Hherson, Ukraine. He copiously wrote treatises in theology, philosophy and the sciences and greatly influenced the development of modern Greek thought,. He translated and taught Andrea Tacqet' *Elementa geometriae.*
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