Mathematics and Literature in Secondary School: an interdisciplinary teaching proposal[1]

R.Capone[2] & G.Pace[3] & F. S. Tortoriello[4]

Abstract: This paper aims to propose an interdisciplinary teaching unit comprising mathematics and literature for the second year of a *Math high school*(an Italian secondary school with a particular focus on mathematics) on the theme "Greek myths on the origin of numbers". By means of a guided analysis of ancient Greek literary texts dealing with myths on the origin of numbers (those of Theuth, Palamedes e Prometheus), students will identify the main functions that the ancient Greeks attributed to numbers and to mathematics, and then form a personal opinion on this topic.

1. Introduction

This article aims to present an interdisciplinary teaching unit comprising mathematics and literature, which has been trialled on students from the second year of a *Math high school*(an Italian secondary school with a particular focus on mathematics) within the context of a research project (Capone, R., et al. 2016) set up three years ago by the Department of Mathematics at the University of Salerno and a dozen secondary schools with a particular focus on science subjects (*Math high school*) in Campania. The project was also partly taken up by the mathematics departments of other universities. At present, there are about 100 *Math high schools* in Italy, but this number is likely to rise in the coming years in view of the considerable interest expressed throughout the country. In particular, the *Math high school* offers additional workshops for the study and further investigation of any links between the humanities and the sciences. This is achieved through the introduction of teaching that aims to find links between the different disciplines in order to identify points of contact between the sciences and the humanities, something that rarely occurs in the teaching field despite the numerous attempts made to determine shared features. This interdisciplinary nature is intended as a way of employing forms of knowledge to ensure understanding of integrated experiences. It should not be considered only as a relationship between the disciplines but as an approach to reality through the disciplines and their relations, which may regard both forms and levels of knowledge.

2. Mathematics and literature in the syllabus of the *Math High School*

Following the indications and objectives of the national curriculum, which for students in the *Math high school* envisage

> *"a balanced education in two main areas: language-history-philosophy and science; an understanding of the fundamental steps in the development of thinking, including a*

---

[1] Paragraphs 1-2 are by R. Capone and F. S. Tortoriello, paragraph 3 by Giovanna Pace

[2] Roberto Capone, Department of Mathematics , University of Salerno, Italy

[3] Giovanna Pace, Department of Humanistic Studies / DIPSUM, University of Salerno, Italy.

[4] Francesco Saverio Tortoriello, Department of Mathematics , University of Salerno, Italy

historical perspective, and the links between methods for the study of mathematics and experimental sciences and those for investigation of the humanities […]"

The syllabus for Mathematics and Literature is founded on the assertion that

"the equations mathematics=calculation and poetry=freedom are both false and indeed they are intertwined and overlap with one another in that mathematics, with its formulae and theorems, is often a source of levity and play while poetry, with its rhymes and rhythms, and also prose are often an exercise in balance and rigour"
(Maroscia et al.; 2016).

This research stems from the need to overcome the dichotomy that the Gentile reform introduced into secondary education. In particular, Gentile stated that:

"Formal education in middle school is an essentially humanistic and yet essentially literary and philological because in literature it is the purest expression of the human soul and philology is the tool needed in order to understand literature"

Likewise, in his preface to the first Italian edition of Snow's essay in 1959, Ludovico Geymonat reopened the debate on the relationship between these two forms of education:

"No one today can be so blind as to be unaware that the existence of two cultures, as different and distant from each other as the literary-humanistic culture and the scientific-technical culture, constitutes a grave crisis within our society" (Geymonat; 1965).

Calvino also hoped for a link between science, philosophy and literature:

"Science must tackle problems not dissimilar to those facing literature: it builds models of the world that are continually undermined, it alternates between inductive and deductive methods, and it must always beware of not confusing its own linguistic convictions for objective laws. A culture will only be able to face this situation when the science problem, the philosophy problem and the literature problem are constantly undermining one another" (Calvino; 1967).

De Mauro (Bernardini C, De Mauro T., 2005) upturns the question

"*Is humanistic thought responsible for the scarce diffusion of scientific culture in Italy?*"

by stating that in society generally and in schools in particular

"*the lack of science is the result of the lack of humanism*"

where the latter is intended as a

"*proportion to the rigorous determination of data, to precise measurements and descriptions, to direct experience*"

As regards the reasons why humanities have gradually been isolated to a substantially marginal, social role:

"Undeniably this has been the result of a series of factors, such as the marked lag in technological and industrial development and its dependent educational input in Italy, where the strategic necessity for industrialisation and the diffusion of scientific methods and knowledge have never been given due attention either in school curricula or in the country as a whole. From an educational standpoint, no reform has made effective progress in raising the level of Italians' basic scientific knowledge, and Italian schools are still firmly anchored to the actualistic, Gentile-based view of education which sees humanities and classics in an unchallenged position of privilege as far as the diffusion of knowledge is concerned". (Antonello P., 2012)

The *Math high school* stresses the importance, both in society generally and in school, of the link and the complementary nature that science and literature share. In particular, the study of literature is proposed as an auxiliary support for the description of mathematical concepts which students often have difficulty in understanding.

Underlying this reasoning is the recognition of how mathematics has been able to influence, or perhaps even condition, the thought process, the poetics and, in some cases, the very literary structure of famous poets and writers through the conviction of the contribution that the reading and analysis of literary texts can offer in understanding the role of mathematical thought in the various historical ages and cultural environments.

The mathematics and literature module in the *Math high school* is organised according to a timetable that calls for five hours in the second year, seven in the third year, eight in the fourth year and ten in the fifth year. In particular, second year students will study the relationship between scientific thought and myths in the ancient world through the study of Archimedes and 1st century BC Latin poetry with Catullus, Virgil and Horace, Structural symmetry in the poetic compositions of Virgil, ancient Greek myths on the invention of numbers and the role of mathematics in ancient Greek theatre on the basis of the following skills-based teaching schedule:

KNOWLEDGE		SKILLS
National guidelines	*Knowledge and understanding*	*applying knowledge and understanding*
Read the works of significant writers from the classical age in translation.	• To learn about the ancient Greek myths on the invention of numbers (Prometheus, Palamedes, Theuth) and the related literary contexts from which they were handed down. • To understand the significance of these myths in Greek culture, with particular reference to the conception of the function and value of mathematics. • To understand the use that the various authors make of the myths on the	• Can identify the relationship between the traditional myths and their use in the literary framework of ancient Greece. • Can observe the relationship between mythical forms and scientific thought in the ancient world. • Can recognise poetic and literary forms based on knowledge of mathematical and scientific thought.

	invention of numbers in relation to the message of the individual works.	

3. "Greek myths on the origin of numbers"

What follows is a proposal of a teaching activity lasting 2½ hours for the module of Mathematics and Literature (with specific reference to ancient Greek literature) in the second year of a *Math high school* .[5]

The topic of the lesson "Greek myths on the origin of numbers" can be understood also by students having no basic knowledge of ancient Greek language and culture (as they are students from the science-oriented) and will prove stimulating to those specifically interested in mathematical theory. This topic will facilitate a presentation of how the ancient Greeks used their particular form of myth narration in order to ask questions, which are still valid today, on the functions of numbers and mathematics and

provide answers linked to their effective use within their cultural framework.

The lesson / workshop, conducted in full participation method and through the use of a Power Point (including images related to iconographic tradition of myths) and the use of LIM, is divided into the following phases:

1. *Brain-storming* on the origins of numbers and their current functions.

On the one hand, this activity makes it possible to check prerequisites swiftly and informally while, on the other hand, it allows the students to observe the relationship of the lesson topic both with their previous learning and with the use of mathematics in daily life and contemporary science. In this way, a first step in stimulating students' interest is achieved.

2. Brief review of the notion of myth, with reference to science and technology.

Starting from what the students already know about myths in general and about certain myths they are already aware of, it is possible to illustrate one of the functions of Greek myths, namely the narrative representation of ideas on the origins, the value and the function of science and technology (cf. Calame, 1999, p. 17). To this end, is presented the figure of the *prôtos heuretés*, the *'first inventor'* or '*discoverer*' of sciences, arts and disciplines, who is always a god or mythical character (cf. Kleingünther, 1933; Cole, 1967, pp. 6-7).

3. Presentation of the lesson topic.

The lesson is based on the analysis of three myths on the origins of numbers: the Egyptian myth of Theuth (mainly known through Plato's dialogue *Phaedrus*) and those of Palamedes and Prometheus. Each of these myths is presented through the reading of Greek texts (in translation) and the teacher leads the class in a guided analysis. Some Greek key-words are presented in transliterated form so that students can reflect on the etymology of some Italian terms and on some central themes of Greek thought regarding science and technology (as an example *sophía* and *téchne*).

---

[5] The lesson / workshop was held in the AIS. 2016/2017 at the *Math high school* (in agreement with the Department of Mathematics of the University of Salerno) at the "Alfonso Gatto" High School of Agropoli (SA) in a class formed by students of the Scientific high school (mostly) and the Classical high school.

4. Guided analysis of the texts.

The texts selected are for Theuth's myth Plato, *Phaedrus,* 274c-275a; for that of Palamedes Aeschylus, *Palamedes,* frr. 181a, 182 Radt; Sophocles, *Nauplius,* frr. 432, 479 Radt; Gorgia, *Defense of Palamedes*, 30; Plato, *Republic,* 522c-d) ; for that of Prometheus, Aeschylus, *Prometheus*, 422-461

Text analysis focuses primarily on two features:

a) an investigation of the inventions which, in various literary contexts, are compared to the invention of numbers in order to identify the functions attributed to them;
b) contextualisation of myths, through which the teacher can develop a basic reflection on the value attributed to knowledge (mainly, but not solely, of mathematical type) at certain stages of Greek civilisation (and, in the case of Theuth, Egyptian civilisation through the mediation of Plato).
The starting point is an analysis of Plato's text on the myth of Theuth.

Plato, *Phaedrus,* 274c-274d

... at Naucratis, in Egypt, was one of the ancient gods of that country ... and the name of the god himself was Theuth. He it was who invented numbers (arithmón) and arithmetic (loghismón) and geometry and astronomy, also draughts (pettéias) and dice (kybéias), and, most important of all, letters (grámmata). Now the king of all Egypt at that time was the god Thamus ... To him came Theuth to show his inventions, saying that they ought to be imparted to the other Egyptians. But Thamus asked what use there was in each, and as Theuth enumerated their uses, expressed praise or blame, according as he approved or disapproved. (translation by Fowler, 1914).

The inventions of Theuth are presented in a logical progression showing the main uses of numbers: from calculus (numerical operations), geometry and astronomy (in which the operations themselves are used to measure distances on the earth and to study the movement of the stars) to tokens and dice (games with numbers which are based on the calculation of probabilities and represent the measurement of a prospective world) and writing (where numerical reality is translated into words) (Sabbatucci, 1994, pp. 199-200). As regards the relationship between numbers and writing, a common feature in ancient Greek literary texts, it is worth laying down some guidelines on the cultural context: in the Milesian system of ancient Greece, numbers were indicated with letters of the alphabet and it was therefore not possible to separate their invention from that of writing (cf. Powell, 1991, p. 235). Analysis of the tale also makes it possible to identify three key concepts of mathematical knowledge in the myth of Theuth: 1. its divine origin; 2. the god's desire to give this knowledge to man; 3. the control exercised by political power (the king), who passes judgment on the utility of inventions. The myth is then contextualised within Plato's dialogue:

Plato, *Phaedrus,* 274e-275a

... when they came to the letters, "This invention, O king," said Theuth, "will make the Egyptians wiser and will improve their memories; for it is an elixir of memory and wisdom that I have discovered." But Thamus replied, "Most ingenious Theuth, one man has ability to judge of their usefulness or harmfulness to their users belongs to another ... For this invention will produce forgetfulness in the minds of those who learn to use it, because they will not practise their memory. Their trust in writing, produced by external characters which are no part of themselves, will discourage the use of their own memory within them.

Plato's use of the myth of Theuth to illustrate one aspect of his criticism of writing (the risk of becoming forgetful; Mariani, 2010, p. 3 s.) makes it possible to develop a discussion on the problems of web-mediated knowledge acquisition (the considerable ease in finding not always reliable information, which may result in superficiality or underdeveloped
critical analysis). In this way it can be implicitly shown how categories of Greek thought can prove functional to a reflection on the present day.

For the myth of Palamedes, the various functions it attributes to numbers can be identified more concisely in this phase of the lesson as the texts will be subjected to direct analysis by students in the group work phase (cf. *infra*). Nevertheless, at this stage it is worth pointing out the privileged position attributed to the invention of numbers and the association of this invention with other discoveries: organisation of the army (Aeschylus, *Palamedes,* fr. 182. 1-2; Sophocles, *Nauplius,* fr. 432. 3; Plato, *Republic,* 522d), organisation of meals (Aeschylus, *Palamedes,* fr. 182. 2-3), weights and measures, interpretation of heavenly signs, use of fire in signalling, measurement of the periodic movements of stars (Sophocles, *Nauplius,* fr. 432), games of tokens and dice (Sophocles, *Palamedes,* fr. 479), discoveries which, for Gorgia, (*Defence of Palamedes*, 30) include the law and the alphabet. The figure of Palamedes as the inventor of numbers (and other disciplines) can be compared with the Palamedes found in the post-Homeric epic tradition, where he is the adversary of Odysseus, having revealed the latter's simulated insanity in order to stay out of the Trojan War, and is able to offer a rational explanation of some phenomena or events regarding him. In this way, it is possible to introduce the concept of a 'cultural hero' (Palamedes), the bringer of *sophía* 'theoretical wisdom', opposed to the traditional hero (Odysseus), brave in battle and the bringer of *métis* 'practical wisdom'. It is worth pointing out that the changes in the assessment of the character of Palamedes and his inventions depend on society changes: Palamedes is absent in the works of Homer, which express the values of an aristocratic society (for which his *sophía* constitutes a threat) but is redeemed in the democratic society of Athens in the 5th-4th centuries BC, in which context all the presented texts were written (cf. Sabbatucci, 1994, p. 200; Guardini, 2002, pp. 60-66).

Prometheus appears as the inventor of numbers in the tragedy of the same name attributed to Aeschylus:

<div align="center">

Aeschylus *Prometheus*, 442-461

</div>

Instead, listen to the miseries of mortals, how infantile they were before I made them intelligent and possessed of understanding. ... In the beginning, though they had eyes and ears they could make nothing of what they saw and heard; like dreams-figures they lived a life of utter random confusion all their days. ... they did everything without planning, until I showed them the hard-to-discern rising and settings of stars. I also invented for them the art of number, supreme among all techniques (éxochon sophismáton), and that of combining letters into written words, the tool that enables all thins to be remembered and is mother of the Muses. (traslation by Sommerstein, 2008)

Text analysis makes it possible to observe an element present both in the myth of Theuth and in that of Palamedes (cf. *infra*): the association of the invention of numbers to that of the alphabet and writing (i.e. to another system of conventional signs) and to astronomical discoveries (i.e. to the interpretation of heavenly signs). Moreover, reflection on the first part of the text fosters an understanding of the value that the author of the tragedy attributes to Prometheus' 'gift' of numbers to men (which recalls another famous 'gift', the theft of fire from the gods which gave rise to material and intellectual civilisation; cf. Griffith, 1983, p. 167): the knowledge of numbers makes it possible to understand the natural universe and thus marks the transition from a state of childish immaturity to one of

full possession and use of intellectual capacity. The very idea of the 'gift' of numbers to all men, which implies a 'lay' and democratic conception of knowledge, clearly highlights how much this myth differs from that of Theuth, where knowledge is of divine origin and controlled by the absolute power.

5. Group work.

The students organise themselves into informal groups of 4 or 5 people to perform two types of activity:
a) identification of expressions or key words within the texts (provided in photocopy) regarding the myth of Palamedes in order to point out the functions attributed to numbers. Aeschylus' fr. 181a. 1-3 *("Then I organized the life of all the Greeks and their allies, which previously had been as chaotic as that of beasts")* points out the civilising function of numbers; Aeschylus' fr. 182 ("*And I appointed brigade and company commanders for the army, and I taught them to distinguish their meals, to take breakfast, dinner and thirdly supper*") and Sophocles' fr. 432. 1 ("*And it was he who devised the wall for the army of the Argives*", translation by H. Lloyd-Jones, 1996) and from Plato, *Republic,* 522d *("... Palamedes in the plays is always making Agamemnon appear a most ridiculous general. Have you not noticed that he affirms that by the invention of number he marshalled the troops in the army at Troy in ranks and companies and enumerated the ships and eveything else as if before that they had not been counted ...*"), the ordinating one, even in a practical way (cf. Powell, 1991, p. 235; Vegetti, 2003, p. 529); Sophocles' fr. 432. 2-8 *("his was the invention of weights, numbers and measures ... he showed the army how to use beacons, and revealed things that earlier were hidden. He discovered how to measure terms and periods for the stars ...")* also indicates the use of numbers to measure (both on earth and in the heavens) and to understand or interpret reality; Sophocles' fr. 479 *("Was it not he who drove famine away from them ... and he who discovered the cleverest ways of passing time for them when they were resting after their struggles with the waves, draughts and dice, a pleasant remedy against idleness?")* clearly points to the recreational function of numbers, although there is also a practical upside, as play and entertainment distract attention from the pangs of hunger (cf. Ceccarelli, 2013, p. 77). Finally, a reading of Gorgia's text (*Defense of Palamedes*, 30), which constitutes a *compendium* of the inventions attributed to Palamedes in the other texts, makes it possible to highlight both the civilising function of numbers and the eminently practical role they play (cf. Ceccarelli, 2013, p. 86) .
This activity allows the students to do experience, albeit embryonic, of one of the tasks of the philologist, namely utilising and comparing different texts in order to reconstruct an aspect of the ancient world, which in this case is constituted by a myth. They also (implicitly) gain awareness of what Canfora 2002, pp. 118-119 (taking up remarks by Brelich, 1972) defines as the 'fragmentary' nature of the evidence of the Greek culture that has survived to the present day: in actual fact, as so little of the ancient world has
come down to us (for instance, in the field of literature, only a limited selection of the texts actually written and some of these also incomplete) it is up to scholars to strive to fill the 'information gaps', despite all the risks and obstacles that this entails.
b) invention and drafting of a brief 'myth' on the origins of numbers (set either in the past or in the present day). This activity fosters creative participation by students, who thus abandon the role of 'philologists' to become 'authors', and it also helps them to grasp and consolidate the contents of the lesson.

6. Sharing the results of the group work

a) The results obtained by each group's text analysis are shared and discussed; these are then summarised in diagram format on the interactive whiteboard.
b) The 'myths' invented by the groups are read and the functions they attribute to numbers are identified.

4.   Conclusions

The teacher can point out how the variety of myths in ancient Greek culture on a single topic (in this case, the origin of numbers) testifies to the intellectual pluralism of a world that is not characterised by a single school of thought and bequeaths to us, among other things, its tireless capacity for investigating reality from different points of view, asking constantly new questions and looking for new answers (cf. Vegetti, 2002, p. 275 s.). The teaching activity proposed has highlighted a high level of involvement of the class and a consequential consolidation of motivation and diligence; moreover, the narrative approach to studying mathematics through myths has fostered networked knowledge and combinatorial creativity (Popova, 2012). Finally, the intrinsic strengths of the narrative mechanism successfully have generated interpretive processes and significant conceptual correlations.

References
Antonello P. (2012), *Contro il materialismo. Le «due culture» in Italia: bilancio di un secolo*, Torino, Aragno Editore
Bernardini C, De Mauro T., (2005), *Contare e raccontare. Dialogo sulle due culture*, Bari, Laterza.
Brelich, A. (1972), *Ad philologos. Religioni e civiltà*, n. s. 1, 621-629.
Calame, C. (2016), *Prometeo genetista. Profitti delle tecniche e metafore delle scienze*, trad. di F. Giorgianni, Palermo, Sellerio.
Calame, C. (1999), *Mito e storia nell'Antichità greca*, trad. di E. Savoldi. Bari, Edizioni Dedalo.
Calvino I., (1967) *Filosofia e letteratura*, Milano, La Fiera letteraria.
Canfora, L. (2002), *Noi e gli antichi*, Milano, Rizzoli.
Capone, R., Dello Iacono U., Tortoriello F. S., Vincenzi G., (2016) *Math high school: a teaching proposal*. In Proceedings of the conference History and Pedagogy of Mathematics, Montpellier.
Capone R., E. Rogora, F.S. Tortoriello (2017), *La matematica come collante culturale nell'insegnamento*, Matematica, Cultura e Società – Rivista dell'Unione Matematica Italiana , Bologna (printing)
Ceccarelli, P. (2013), *Ancient Greek Letter Writing: A Cultural History (600 B.C.-150 B.C.)*, Oxford, Oxford University Press.
Cole, A. T. (1967), *Democritus and the sources of Greek anthropology*, Cleveland, OH: Wester Reserve UP.
Fowler, H. N. (1914), *Plato. Eutyphro – Apology – Crito – Phaedo – Phaedrus.* Cambridge (Mass.), London, Harvard University Press.
Geymonat, L., (1965) "Prefazione" a Snow, P., *Le due culture*, Feltrinelli, Milano.
Griffith, M. (1983), *Aeschylus. Prometheus Bound*, Cambridge, Cambridge University Press.
Guardini, M. (2002), *Le forme della sapienza in Odisseo e Palamede*. In L. de Finis, V. Citti (edd.), *Odisseo dal Mediterraneo all'Europa* (pp. 57-66). Amsterdam, Hakkert.
Kleingünther, A. (1933). *Πρῶτος εὑρετής*. Philol. Suppl. 26 (1).
Lloyd-Jones, H. (1996), *Sophocles, III: Fragments*, Cambridge (Mass.) – London, Harvard University Press.

Mariani, S. (2010), *Gorgia di Lentini. Difesa di Palamede*, Genova, Il Melangolo.

Popova, M. (2012), *A Brief History of Children's Picture Books and the Art of Visual Storytelling*, Brain Pickings.

Powell, B.B. (1991), *Homer and the origin of the Greek alphabet*. Cambridge, Cambridge University Press.

Maroscia P., Toffalori C., Tortoriello F. S., Vincenzi G.,(2016), Introduzione a, *Matematica e letteratura analogie e convergenze*, Torino, UTET.

Sabbatucci, D. (1994), *Da Thot a Palamede*. In G. Sfameni Gasparro (ed.), Ἀγαθὴ ἐλπίς. Studi storico-religiosi in onore di Ugo Bianchi (pp. 197-202). Roma, L'Erma di Bretschneider.

Shorey, P. (1935), *Plato. Republic, VI: books 6-10*. Cambridge (Mass.) – London, Harvard University Press.

Sommerstein, A.H. (2008), *Aeschylus. I: Persian Seven against Thebes Suppliants Prometheus Bound. III: Fragments*, Cambridge (Mass.) – London, Harvard University Press.

Snow C. R., (2005), *Le due culture*, Venezia, Marsilio.

Vegetti, M. (2002), *Classico o antico*? In I. Dionigi (ed.), *Di fronte ai classici. A colloquio con i Greci e i Latini*, (pp. 267-278). Milano, Rizzoli.