Schooling the Discoveries. Jesuit Education Between Science and Geographic Literacy in the Age of Iberian Expansion (15th-18th c.)*

*Part I***

Henrique Leitão
David Salomoni

University of Lisbon
History of Science Department
Campo Grande, 1749-016, Lisbon
leitao.henrique@gmail.com
dsalomoni@fc.ul.pt

Abstract
The change of pedagogical paradigms occurred during the Sixteenth century has often been related to the rupture of religious unity and the processes of political centralization of European states. In the same period, however, historiography has neglected the influence on the school world exerted by the maritime expansion and the geographical discoveries made by the Iberian kingdoms. So far, the prevailing hypothesis stated that geography entered significantly into school classrooms only in Nineteenth century England, as an effect of modern colonialism. In this study, the two authors show the role of the Society of Jesus in redefining the assumptions of geographical and scientific teaching as a defining element of early modern Catholic education.

Keywords: Jesuit Education; Geographic Literacy; Cosmography; Age of Discoveries; Maritime Expansion.

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Resumen

Escolarizando los descubrimientos. La educación jesuita entre la ciencia y la alfabetización geográfica en la época de la expansión ibérica (siglos XV-XVIII)

El cambio de paradigmas pedagógicos ocurrido durante el siglo XVI se ha relacionado a menudo con la ruptura de la unidad religiosa y los procesos de centralización política de los estados europeos. Sin embargo, la historiografía no ha considerado adecuadamente la influencia que, en ese período, ejercieron en el mundo escolar la expansión marítima y los descubrimientos geográficos de las coronas ibéricas. Hasta ahora, la hipótesis predominante afirmaba que la geografía entró de forma significativa en las aulas escolares sólo en la Inglaterra del siglo XIX, como efecto del colonialismo moderno. En el presente estudio, los autores muestran el rol de la Compañía de Jesús en la redefinición de las bases de la enseñanza geográfica y científica como elemento definitorio de la educación católica de la primera época moderna.

Palabras clave: Educación jesuita; Alfabetización geográfica; Cosmografía; Edad de los descubrimientos; Expansión marítima.

In his recent work on the pre-suppression Jesuit school system, Paul Grendler, speaking of the school taken charge of by the Society of Jesus in the Portuguese colony of Goa in 1543, stated that "the Goa school did not serve as a model and had little or no influence on Jesuit education in Europe for reasons of distance and chronology"[1]. To support his argument, Grendler points out some technological aspects involved in the world-wide circulation of both people and cultural models. In particular, he stresses the fact that:

> There was limited communication about schools between Asia and Europe because travel was difficult and very slow. A Jesuit or a letter between East Asia and Europe needed to travel six months each way in order to reach a given destina-

[1] P. Grendler, *Jesuit Schools and Universities in Europe 1548-1773* (Leiden-Boston: Brill, 2019), 4.

> tion. And both humans and letters were subject to shipwreck and other disasters[2].

While Grendler's overall characterization is not in doubt (the Goa school was never itself a model capable of influencing Jesuit schools in Europe), the question remains whether the processes of early modern maritime expansion and overseas colonization could influence and intertwine with the new educational paradigms developed by the Society of Jesus.

In other words, we must ask if, and to what extent, the redefinition of the world's cosmography through early modern Iberian explorations contributed to an equivalent redefinition of European pedagogy. Such a process would have been effected by exploiting the capillarity of the Jesuits' educational networks. These pedagogical transformations may then be weighed against changes to schooling wrought by concomitant religious and political upheavals.

In this regard, historians have brought to light factors that are only indirectly related to such questions. On the one hand, historians of education have underlined the religious, political, and economic aspects of the educational turn in Europe between the sixteenth and seventeenth centuries[3]. On the other hand, historians of science and cultural historians of the first globalization have highlighted the far-reaching cultural impacts of the encounters of westerners with unfamiliar civilizations. Some modern histories of science have, however, given little space to the role of the early mod-

[2] *Ibidem*.

[3] P. Grendler, *Schooling in Renaissance Italy. Literacy and Learning, 1300-1600* (Baltimore-London: Johns Hopkins University Press, 1989).

ern geographical discoveries in their assessments of the shifting structure of education[4].

In both historiographical traditions, the implications of the Iberian expansion for European educational cultures have been broadly neglected[5]. As to when a full awareness of extra-European realities entered classrooms, scholarly consensus so far looks to the nineteenth century (and, in particular, to England, as a consequence of European imperialism)[6]. Our hypothesis is that pre-university teaching of geography, due to the major transformation in economics, politics, religion, and culture triggered by the Iberian maritime expansion, represented a much earlier turning point in European educational culture.

A possible explanation for the lack of a historiographical link between the sixteenth century pedagogical turn and the new shape of the world can be found in the enormous historiographical success of the great astronomical debates of the seventeenth century. These were so exciting as to overshadow the terrestrial side of an ongoing process of cosmographic redefinition. The struggle between Galileo and Bellarmino, the Dispute on Comets, the tormented debate between Copernican and Tychonian system have led historians to pour out rivers of ink[7].

[4] On the Iberian role in western scientific history refer to J. Pimentel, "The Iberian Vision: Science and Empire in the Framework of a Universal Monarchy, 1500-1800". *Osiris*, 2nd Series, Vol. 15, *Nature and Empire: Science and the Colonial Enterprise* (2000): 17-30.

[5] For the history of science and globalization see S. Gruzinski, *Les quatre parties du monde: Histoire d'une mondialisation*, Paris: Éditions de La Martinière, 2004; Id., *L'Aigle et le Dragon. Démesure européenne et mondialisation au XVIe siècle* (Paris: Fayard, 2012).

[6] D. Cosgrove, *Apollo's eye: A Cartographic Genealogy of the Earth in the Western Imagination* (Baltimore-London: The Johns Hopkins University Press, 2001), 225.

[7] Nor have the educational consequences of these issues have been ignored, as shown by the attention paid to the removal of Cristoforo Borri

Nevertheless, the physiognomy of the earth 'changed' together with that of the sky. Between the sixteenth and seventeenth centuries, what has been called a 'cosmographic revolution' was gaining just as much momentum as the 'astronomic revolution'[8]. The two phenomena were, indeed, parts of the same transformation. As the Europe's understanding of the place of the earth in the universe changed, so did the shape of its surface. The debate on the configuration of the earth does not seem to us as bitter as the one on the celestial spheres. If scholars could maintain lively disputes about distant heavenly bodies, there was less room for argument about directly-experienced terrestrial affairs.

However, as we shall see, even in school environments there was no lack of divergent opinions on how to represent the Earth's surface, despite the presumably unambiguous empirical dimension of geographical discoveries. Among the most important examples we find

from the Brera Jesuit college for having taught the Tychonian system. See: L. M. Carolino, "Astronomy, Cosmology, and Jesuit Discipline, 1540-1758," In *The Oxford Handbook of the Jesuits*, edited by Ines G. Županov (New York: Oxford University Press, 2019), 670-707. Although historiography has now gone beyond the simplistic reading of an opposition between science and faith, the myth of the Black Legend holds a tenacious grip on the collective imagination. See J. H. Brooke, *Science and religion. Some historical perspectives* (Cambridge: Cambridge University Press, 1991); K. Howell, *God's two books: Copernican cosmology and biblical interpretation in early modern science* (Notre Dame: University of Notre Dame Press, 2002); and W. T. Cavanaugh, *The Myth of Religious Violence* (Oxford: Oxford University Press, 2009). On the Galileo affaire see: R. Numbers, *Galileo goes to jail and other myths about science and religion* (Cambridge: Harvard University Press, 2009).

[8] K. A. Vogel, "Das problem der relativen Lage von Erd und Wassersphäre im Mittelalter und die kosmographische Revolution", *Mitteilungen der Österreichischen Gesellschaft für Wissenschaftsgeschichte*, XIII (1993): 103-143. The expression is also reported in S. Mammola, "Il problema della grandezza della terra e dell'acqua negli scritti di Alessandro Piccolomini, Antonio Berga e G. B. Benedetti e la progressiva dissoluzione della cosmologia delle sfere elementari nel secondo '500", *Preprints of the Max Planck Institute for the History of Science*, 459 (2014): 1-62.

is the opposition between the theory of American insularity and Amerasian continuity in relation to the newly discovered continent, which dominated scientific debates between geographers and cartographers throughout the sixteenth century[9].

Portuguese and Spanish ships made decisive contributions to this process of redefinition. If communication between Asia and Europe, as Grendler has said, was slow by current standards, the fact remains that this was the first time in human history in which such contacts existed on a stable basis[10]. The establishment of stable worldwide networks was made possible by the most advanced technological devices of the early modern age. However, in order to represent a true cultural revolution, these cosmographical achievements needed an adequate institutional structure: something sufficiently solid, well-connected, and, perhaps less obviously, capable of combining old and new forms of production and transmission of knowledge.

The dramatic changes taking place in Europe during the sixteenth century had fostered intellectual energies capable of meeting these challenges. As we shall

[9] R. Padrón *The Indies of the Setting Sun: How Early Modern Spain Mapped the Far East as the Transpacific West* (Chicago: The University of Chicago Press, 2020). On the conformation of the Earth there was no lack of religious contrasts too. For instance, on the Italian translation of Sebastian Münster *Cosmographia Universalis*, the Dominican friar Andrea Bosturino states that in the edition he "pulled out the thorns and cast out the shadows of errors that were departing from the Roman Catholic church" (*ho cavato le spine e scacciati l'ombre d'errori che scostavano dalla Catolica romana chiesa*). Cfr. S. Münster, *Cosmographia Universale* (In Colonia: appresso gli heredi d'Arnoldo Byrckmanno, 1575), 2.

[10] L. Jackson, *Globalization and Education*, in *Oxford Research Encyclopedia of Education*. Published online October 2016; and A. Giddens, *The consequences of modernity* (Cambridge, U.K.: Polity, 1990), 64. M. W. Lewis and K. E. Wigen, *The Myth of Continents: A Critique of Metageography* (Berkeley-LosAngeles-London: University of California Press, 1997), 25-28.

see, the the followers of Ignatius of Loyola, one of the most distinctive characters of the time, combined ancient and new forms of knowledge. In so doing, they created a network of educational institutions characterized by a degree of capillarity and pedagogical uniformity unprecedented in European history.

Now, if the premise appears to be clear, the problem is complex. As we shall see shortly, it would be an oversimplification to say that the Society's pedagogical solutions represented a simple critique of the Aristotelian cosmology with which the physical nature of the universe had been construed and taught until then. Geographical discoveries certainly represented a further cracking of the already-embattled Aristotelian system, but at the same time they were a new locus of study within Aristotelianism itself. In this respect, the discoveries became the object of reflection and the cause for the revival of a dialectic instrumental to its persistence[11].

Some historians have even argued that the Jesuits' deep interest in the cosmographic and cartographic sciences was more motivated by Catholic imperialist universalism, both from a religious and political point of view, than by a genuine pedagogical commitment[12]. Although these two factors are not mutually exclusive, it is necessary to emphasize how much the Jesuit schools' cultivation of 'geographical literacy' influenced European scientific thought.

This article aims at providing a first overview of how the scientific and technical achievements made possible by early modern Iberian geographical discover-

[11] On the complex debate around Renaissance Aristotelianism, refer to the classic (but always valid) work of C. B. Schmitt, "Towards a Reassessment of Renaissance Aristotelianism," *History of Science*, 11, 3 (1973): 159-193.

[12] Cosgrove, *Apollo's Eye*, 159-166.

ies could merge with the pedagogical and intellectual turn that affected Europe during the sixteenth century. The objective is to verify is whether, and to what extent, the empirical and theoretical achievements obtained by oceanic navigation and maritime expansion represented, thanks to the institutional role of Jesuit schools, a decisive element in laying the basis for the methodological and epistemological scientific changing of the seventeenth century, at least in the Catholic world.

The article will be divided into three parts. The first and the second parts, which are structurally entangled, will address tradition and innovation in the geography taught in the European school system before and after the beginning of the Iberian maritime expansion. In these parts of the article, the impact of oceanic exploration on the contents of school curricula will also be assessed. The third part of the article aims at understanding the scope and the scale of diffusion of geographical literacy between sixteenth and seventeenth century. It approaches this question through a series of examples ranging from rural villages and Italian towns, to European and extra-European Jesuit colleges[13].

1. *Continuity and innovation: the teaching of cosmography in the Renaissance*

Between the sixteenth and the seventeenth centuries two processes of great importance for Western history came to their culminations. On the one hand, the impetus given by the Iberian monarchies to the exploration of the

[13] S. J. Harris, "Confession-Building, Long-Distance Networks, and the Organization of Jesuit Science", *Early Science and Medicine, Jesuits, and the Knowledge of Nature* 1, 3 (1996): 287-318.

world entered its golden age[14]. In 1522, the expedition initially led by Ferdinand Magellan (and completed by Juan Sebastian Elcano) had finished the first circumnavigation of the world. It was only from the second half of the century, however, that a series of stable colonies across Asia, Africa, America, and Europe gave birth to an integrated and functioning global system for the circulation of travelers and goods. We can consider this process to have been completed by 1565, when a stable maritime route from East Asia to West America was established by the Manila Galleon[15].

In an apparently different domain, in 1599 the Jesuit *Ratio Studiorum*, the most important rule of study in Catholic Europe, was completed. Following its example, the rules of study for other religious teaching orders active in post-Tridentine Europe were developed. In 1600 the Somascan Fathers prepared the *Regole circa lo studio* (Rules for studying). In 1666 the Barnabites completed the *Exterarum Scholarum*, and in 1694 the *Ratio Studiorum Pro Exteris* of the Piarist Fathers was set[16]. What was the connection between these two phenomena? Did the process of exploration and integration of the four parts of the world, and the resulting emergence of new scientific concepts, affect the way knowledge was produced and transmitted in Europe?

To answer this question, we must take a step back. After all, the pedagogical revolution implemented by the Jesuits, which was instrumental to the development of the *Ratio Studiorum*, happened before 1599. The ed-

[14] See B. Yun-Casalilla, *Iberian World Empires and the Globalization of Europe, 1415-1668* (London: Palgrave Macmillan, 2019).

[15] J. L. Gasch-Tomás, *The Atlantic World and the Manila Galleons: Circulation, Market, and Consumption of Asian Goods in the Spanish Empire, 1565-1650* (Leiden-Boston: Brill, 2018).

[16] D. Salomoni, "Networks of Schools. The Diffusion of Religious Teaching Orders in Early Modern Italy (16th-18th c.)," *Educazione. Giornale di pedagogia critica*, VIII, 2 (2019): 7-31.

ucational institutions from which the Jesuits drew their inspiration had medieval origins. These were the University and the College. Medieval university teaching was organized into two levels. The first was the *Trivium*, which included grammar, rhetoric, and logic. The second was the *Quadrivium*, in which arithmetic, geometry, astronomy, and music were studied.

Colleges arose after universities, during the fourteenth century, as distinct institutions. As John O'Malley has explained, in contrast with universities, whose purpose was the transmission of knowledge, the educational programs of the colleges, known as *studia humanitatis*, focused on authors and disciplines that had no place in university curricula. The colleges had as their objective the moral education of their students[17].

Although there was no rigid binary between college and university, scientific teaching was mainly entrusted to the latter. It was in the synthesis of knowledge transmission and moral education that the pedagogical innovation of the Jesuits proved most successful. While entering the European universities always remained an important goal, it was the reinterpretation of the collegiate institution that became the most distinctive feature of the Society. Through the application of the *Modus Parisiensis* to colleges, borrowed from Ignatius's experience at the Ste. Barbe College, the Jesuits started teaching some of the university disciplines in their schools. As O'Malley notes, "among them was natural philosophy, the seedbed for the development of modern science and a subject that was especially attractive to

[17] J. W. O'Malley, S.J., "Historical Perspectives on Jesuit Education and Globalization," in *The Jesuits and Globalization: Historical Legacies and Contemporary Challenges*, edited by Thomas F. Banchoff and José Casanova (Washington, DC: Georgetown University Press, 2016), 147-168.

the young laymen for whom the schools were intended"[18].

Once this has been cleared up, we shall understand the contents of Jesuit collegiate teaching with respect to natural philosophy and cosmography. It is worth starting with a few words on Aristotle's role in sixteenth-century education.

By the end of the fifteenth century, Plato's pupil was no longer considered 'The' philosopher. He never ceased, however, to be the lexicon of philosophy, providing the categories with which reality was filtered and interpreted. If Aristotle's use was by now largely limited to school and university classrooms, his ideas were still structurally central to the professionals of knowledge who continued to attend the universities of Padua, Paris, and Alcala for a long time after Galileo's death. In other words, Aristotle remained the Course of Philosophy[19].

However, in the case of cosmography, to fully grasp this change, we must make a comparison with what was taught before the Jesuit arrival into the world of pedagogy. Late-medieval humanistic culture had no problem reconciling its own conception of cosmography with that of the ancients, since until the end of the fifteenth century the shape of the known world had remained essentially unchanged. The main authorities in the field were Aristotle, Pliny, Strabo, Pomponius Mela, and after the 1406 Latin translation of the *Geography*, Ptolemy. It is worth noting that fifteenth-century humanistic culture was more interested in the textual use of Ptolemy than his cartographical remedies; Ptolemy's

[18] *Ibid*., 156.

[19] C. Casalini, *Aristotle in Coimbra. The Cursus Conimbricensis and the Education at the College of Arts* (London-New York: Routledge, 2016), 95-96.

writing on the production of charts and maps would only gain importance in the sixteenth century[20].

In addition, it should be noted that late medieval cosmography was not taught exclusively in universities. Lessons in geography were given to the offspring of the reigning Italian dynasties. A copy of Ptolemy's *Geography*, for example, is listed in a 1488 inventory of the ducal library of Pavia. It is a fine edition that was published in Bologna in 1477 and used for the education of the young dukes of Milan[21]. Other instances of this princely geographical education are documented in the courts of Mantua and Ferrara.

In this regard, Isabella d'Este offers an interesting case study. Her education in Ferrara was deeply influenced by the interest of her father, Ercole I, in geographical discoveries and oceanic navigation. The great planisphere sent to Ferrara by the Este ambassador to Lisbon, Alberto Cantino, hanging in the rooms of the San Giorgio castle, left a mark on the young princess. The noblewoman's interest in the new shape of the world would re-emerge years later in Mantua, where between 1522 and 1523 Isabella and her son Federico II Gonzaga were among the first sponsors of the famous *Relazione* of Antonio Pigafetta, who had just returned to Italy after his circumnavigation of the world[22].

[20] See J. Branch, The Cartographic State: Maps, Territory, and the Origin of Sovereignty (Cambridge: Cambridge University Press, 2014), 51.

[21] M. Azzolini, *The Duke and the Stars: Astrology and Politics in Renaissance Milan*, (Cambridge-London: Harvard University Press, 2013), 50, 281. The edition of Ptolemy's *Geographia* was edited by the humanists Pietro Buono Avogario, Girolamo Manfredi, and Galeotto Marzio, with Cola Montano. See *Cosmographia: Bologna, 1477*, introduction by Raleigh A. Skelton (Amsterdam: N. Israel, Meridian Publishing Co., 1963).

[22] On the backing given by Isabella d'Este and Federico II Gonzaga to Antonio Pigafetta for the publication of the Report of the first trip around the world, see A. Canova, ed., *Relazione del primo viaggio attorno al mondo*, by Antonio Pigafetta (Padova: Editrice Antenore, 1999), 24-25.

In the cities of Mantua and Ferrara, moreover, we find evidence of lively scientific activity, thanks to the protection given by the respective dukes to their large Jewish communities. It is no coincidence that the famous geographer Abraham ben Mordecai Farissol (1451-1525), the first Jew to deal in detail with the discovery of America, lived and died between Mantua and Ferrara[23].

Nor were other social groups denied a geographical education. We may find proof of this in the existence and use of *La Sfera* (or *De Sphera*), a schoolbook of cosmography produced in Florence at the beginning of the fifteenth century, probably written between 1422 and 1435. The attribution of the work is uncertain. It may have been composed by either Leonardo (1360-1425) or Gregorio Dati (1362-1435), who were brothers. Leonardo was a Dominican theologian, philosopher, and preacher who became the General of the Order in 1414. Among Leonardo's scholarly productions is a commentary on Aristotle's meteors. Gregorio, on the other hand, was a humanist and merchant active in Florence. In either case, the cultivated and erudite origin of this manual is evident[24].

[23] D. B. Rudermann, *The World of a Renaissance Jew: The Life and Thought of Abraham ben Mordecai Farissol* (Cincinnati: Hebrew Union College Press, 1981).

[24] Doubts about the attribution of *De Sfera* persist in modern historiography. Denis Cosgrove, for example, mentions as author of the book Leonardo Dati (cfr. *Apollo's Eye*, 96-98), while for R. Clemens the authorship is to be attributed to Gregorio. R. Clemens, "Medieval Maps in a Renaissance Context: Gregorio Dati and the Teaching of Geography in Fifteenth-Century Florence", in *Cartography in Antiquity and the Middle Ages Fresh Perspectives, New Methods*, edited by Richard J.A. Talbert and Richard W. Unger (Leiden-Boston: Brill, 2008), 237-256. On the dispute see: P. Viti, "Dati Leonardo", in *Dizionario Biografico degli Italiani*, 33 (1987).

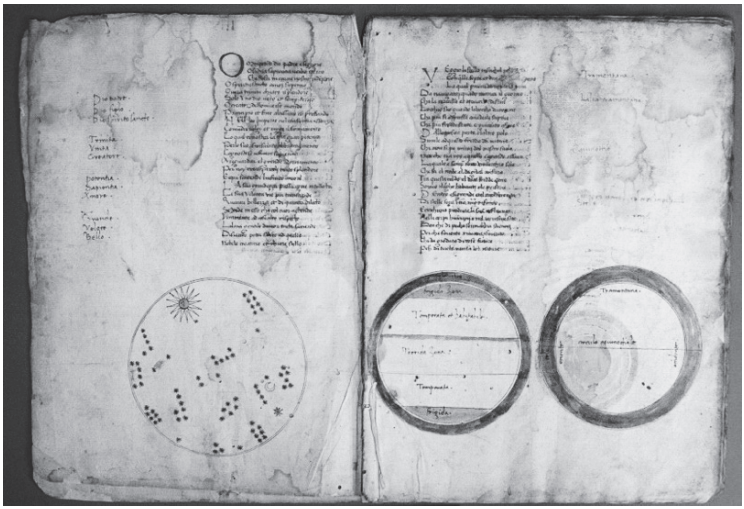

*Image 1. Pages from "*La Sfera Dati" *showing climatic areas of the Earth (15th century)*

The booklet was most likely intended for the education of children from the rich Florentine merchant bourgeoisie[25]. The text consists of four books of equal length written in vernacular verse, beginning with the sky and ending with the earth. Although its main source was John Holywood's popular *Tractatus De Sphaera*, the Florentine book included something new for a schoolbook, namely an accurate description of the Mediterranean coasts accompanied by fragments of portolan charts used by sailors for navigation. These maps are ordered from east to west, and span the shores from the Black Sea to the Atlantic[26].

As an educational tool, the *Sfera* shows elements of both innovation and continuity. Its vision of the world is

[25] G. Dati, *La Sfera* (Milano: G. Daelli e Comp. Editore, 1865).

[26] Clemens*, Medieval Maps in a Renaissance Context: Gregorio Dati and the Teaching of Geography in Fifteenth-Century Florence*, 237-256.

still medieval, and its pedagogical aims are clearly oriented towards a practical end. The *Sfera* shows the earth in its cosmological context and describes the two most common geographic models used to depict it (Macrobius's zonal map and Isidore of Seville's T-O map). Beyond the northern coast, Mauretania to the west, and Ethiopia to the east, Africa is treated very vaguely. However, Dati's close connection to the world of navigation allows him to make a novel contribution in his details of shorelines, demonstrating the early impact of mariners on cosmographic literature and its teaching.

The Florentine roots of this book are no historical accident. Italian humanisms, indeed, developed an early affection for geography[27]. After Jacopo Angelo's Latin translation of Ptolemy's *Geography* in 1406, the interest of Italian intellectuals in maritime expansion, and in particular the one spearheaded by the Portuguese, intensified[28]. As has been astutely observed, "Italians and Portuguese of the fifteenth century learned about geography from each other"[29]. As Donald Lach has pointed out, the Portuguese inherited the techniques for preparing portolan charts from Genoese and Venetian sailors, and the Florentine cosmographer Paolo dal Pozzo was consulted by King Alfonso in 1472 to find the shortest way to India. It was in Florence that, from the second

[27] See A. Cattaneo, "Orb and Sceptre: Cosmography and World Cartography in Portugal and Italian Cities in the Fifteenth Century," (531-555), and M. Rosen, "Charismatic Cosmography in Late Cinquecento Florence," [575-590], in *Archives Internationales d'Histoire des Sciences* special issue: *Early Modern Cosmography*, edited by Sven Dupré and Fernand Hallyn 59.2 (2009).

[28] On Angelo's translation of Ptolemy see N. Lozowsky, "The Earth is Our Book". *Geographical Knowledge in the Latin West ca. 400-1000* (Ann Arbor: The University of Michigan Press, 2000), 8-10, and R. Weiss *Medieval Humanist Greek*, (Padova: Editrice Antenore, 1977).

[29] D. F. Lach, *Asia in the Making of Europe*, vol. 2 *A Century of Wonder*, b.3, *The Scholarly Discipline* (Chicago and London: The University of Chicago Press, 1977), 450.

half of the fifteenth century, the first attempts to reconcile Ptolemaic cartography with the medieval cartographic tradition and the results of the first Atlantic navigation were made[30].

We also know that information on the Portuguese voyages was being regularly received in Florence[31]. Tuscan humanists Poggio Bracciolini and Angelo Poliziano corresponded, respectively, with Prince Henry the Navigator, and King John II of Portugal. A keen awareness of the Iberian discoveries likewise emerges in the works of other intellectuals, such as Pietro Bembo, Francesco Guicciardini, and Paolo Giovio[32].

The evolution of cartography is another mirror reflecting the process of Iberian exploration. This was as a pioneering early modern technological product which represented a true cultural revolution, although one with a circumscribed audience. It is not possible to reduce this field to a unitary framework of development, because cartographic productions responded to different uses and, above all, to different political projects. The making of nautical charts, for example, had very precise technical purposes related to the steering of a ship at sea. This type of chart, therefore, captured relatively limited areas that allowed a high level of precision, thanks also to the practical feedback they allowed. The production of planispheres (as well as the mathematical exercises behind it), was, in contrast, related to a type of conceptualization sensitive to the political needs of emerging global empires[33].

[30] I. Luzzana Caraci, *"Per lasciare di me qualche fama". Vita e viaggi di Amerigo Vespucci* (Roma: Viella, 2007), 111.

[31] Lach, *Asia in the Making*, 450.

[32] P. Burke, *The European Renaissance. Centres and Peripheries*, (Oxford: Basil Blackwell, 1998), 277-278.

[33] In relation to these issues see R. Padrón, *The Indies of the Setting Sun*, 2020, and Id., *The Spacious Word. Cartography, Literature, and Em-*

In addition, the technical and mathematical skills required for producing maps were the prerogative of a select few[34]. Even in the educational field, Dati's *Sfera* was, in its own way, an exceptional object. It was a book reserved for a relatively small number of students (namely, the children of wealthy merchants imbued in humanist culture) and it cannot not be considered a tool for the wider public. The circulation of cosmographic acquisitions was not made easier by the secret with which information about new discoveries was kept by monarchs.

Even the 1502 arrival of Cantino's map in Italy was the result of a borderline illegal mission made at the behest of the Duke of Ferrara. The most advanced planispheres and maps, throughout the sixteenth century, were confined to the salons of monarch and institutions specifically charged with commerce and navigation, such as the *Casa da India* in Lisbon, or *La Casa de la Contratacion* in Seville.

The history of cartography, therefore, is the history of the production of a new geographical awareness, but it is not the history of the diffusion of this knowledge to wider swaths of society. Such diffusion would have been best achieved through institutions capable of re-routing information from the 'high places' of geographical production to the urban and rural populations of Europe. Such a role was filled by pre-university schools in their variety of institutional forms created during the sixteenth century.

Taking the knowledge preserved in Dati's *Sfera* as a benchmark, what changed, if anything, in the cosmography taught in schools after new geographical discov-

pire in Early Modern Spain (Chicago: The University of Chicago Press, 2004).

[34] R. Padrón, "Mapping Plus Ultra: Cartography, Space, and Hispanic Modernity", *Representations*, 79 (2002): 28-60.

eries were made, and why? It has been widely accepted that the mere fact of geographical discoveries was not enough to automatically upend the collective conception of the world; but can schools have been a starting place for that process?

As Edmundo O'Gorman stated, and Martin Lewis and Kären Wigen later affirmed, after being discovered, "America had to be intellectually 'invented' as a distinct parcel of land - one that could be viewed geographically, if not culturally, as equivalent to other continents"[35]. In this regard, Ricardo Padrón added that in order to understand this process of cultural construction, it is necessary to disconnect from the simple idea of adding a fourth part to the tripartite representation of the world. It is likewise imperative to abandon any teleological or deterministic perspective in which the American continent, thanks to a gradual process of exploration, was mapped with increasing precision[36].

In fact, as already mentioned, several hypotheses about the nature and role of the American continent competed for dominance in the Hispanic and European geopolitical imaginary until at least the end of the sixteenth century. There was an insular hypothesis and a hypothesis of continuity between America and Asia that had a long and significant influence on cartographic

[35] Lewis and Wigen, *The Myth of Continents*, 25; and E. O'Gorman, *The Invention of America: An Inquiry into the Historical Nature of the New World and the Meaning of Its History* (Bloomington: Indiana University Press, 1961).

[36] With this perspective we understand why a description of New Mexico is contained in the 1586 best-seller *Historia del Gran Reino de la China* (see Padrón, *The Indies of the Setting Sun*, 2-3) while the popular French text *La Division du Monde*, published five times in Paris between 1539 and 1560 simply makes no mention of America, at all. See Lach, *Asia in the Making of Europe*, 2/3, 461.

production and generally on the way of conceptualizing geography in Europe[37].

The complexity of this situation raises the question of how geographical knowledge was absorbed, elaborated upon, and redistributed by schools. Because of the scarcity and extreme dispersion of sources relating to public schools in the first half of the sixteenth century, particularly on such specific topics, it is difficult to reconstruct what happened in the educational-geographical field. However, we can go into the same theme with relative certainty starting from the 1540s. It is here, I believe, that the role of the Jesuits and their schools is rooted.

2. *The Jesuit Shift: Portugal, Cristoph Clavius and the Messina College*

In this regard, it is worth mentioning the early connection of the Society of Jesus with the Kingdom of Portugal. From the prehistory of the Society, at the time of

[37] The purpose of this complex geographical process of conceptualization, which for reasons of space cannot be dealt with here, responded to the need of integrating the globe's hemisphere assigned to Spain by the Treaty of Tordesillas in 1494 into a coherent space. This vast space extended from the mouth of the Amazon River to an undefined point of the extreme edge of East Asia, which was cut in the middle by the enormous extension of the Pacific Ocean. It required a great effort of abstraction to be characterized and represented as a whole, especially in the Western cartographic tradition as it began to be defined from the sixteenth century, which placed Europe and the Atlantic at the center, and the Pacific at the edge, as a breaking point. This theme is treated by Ricardo Padrón (2020), who brings to light how also in the linguistic field the most common definition in Spanish geographical literature to define its colonial ramifications was *Las Indias*, to indicate the entire hemisphere of relevance, divided into *Las Indias del Norte* (North America), *Las Indias del Sur* (South America), and *Las Indias del Poniente* (East Asia), thus overturning the perspective on East Asia which became the "far west" of the Spanish empire. Padrón, *The Indies of the Setting Sun*, 32.

Ignatius's studies in Paris, Diogo De Gouveia (the director of the college of Sainte-Barbe) was a leading intellectual in the service of the Lusitanian monarchy. Gouveia served two Portuguese kings, Manuel I and especially John III, with whom he advocated for the coming of the first Jesuit missionaries, notably Francis Xavier[38].

As has been written, in Portugal the Jesuits immediately enjoyed a contiguity with monarchic power that would be a characteristic feature of the Society until its suppression in 1773. The longstanding link between the Society and the Portuguese crown was a critical element in defining its identity[39]. The Portuguese Jesuit Province, in fact, was the first to be established. There, the Jesuits implemented the zealous program of missionary-cum-pedagogical work that was to become a defining trait of the Society.

The first Lusitanian Jesuits were hyper-exposed to all aspects of the main enterprise of the Portuguese monarchy: the consolidation of its colonial empire[40]. Politics, economy, science, religion, and education were all involved in this project. The long-range missionary efforts in East Asia, which was the initial reason for the Jesuit presence in Portugal, soon merged with educational objectives as the Society became active in the most prestigious educational institutions of the realm.

[38] On Gouveia see Casalini, *Aristotle in Coimbra*, 62.

[39] *Ibidem*. On the first Jesuits in Portugal see D. Alden, *The Making of an Enterprise. The Society of Jesus in Portugal, Its Empire and Beyond, 1540-1750*, (Stanford: Stanford University Press, 1996).

[40] As it was written, "au contraire des décennies précédentes, les années 1530 constituent une période difficile à définir dans l'histoire du Portugal. Au cours de cette période, la logique expansioniste, mise en place en autre moment, atteint son terme : la règle semble être de consolider plutôt que de s'écarter de la voie tracée". S. Subrahmanyam, *L'empire portugais d'Asie, 1500-1700* (Paris: Editions Points, 2013), 144.

Missions overseas and the methods of educational provision were bound to influence each other.

Because of this situation, it makes sense that some of the figures most instrumental in defining the early modern rules of study were educated in the environment most directly involved in the process of maritime expansion. A key example is Jesuit mathematician Christoph Clavius, who studied in the Portuguese university of Coimbra between 1555 and 1560. Among the intellectuals who most influenced Clavius, it is not surprising to find Portuguese cosmographer, cartographer, and mathematician Pedro Nunes.

Although Nunes seems not to have been one of Clavius's professors at Coimbra, nor can we be certain of a direct relationship between the two, it is the German Jesuit himself who informs us of the importance of Nunes's thought on his intellectual development[41]. As Ugo Baldini wrote, "tra i matematici del medio Cinquecento Pedro Nuñez fu uno dei più influenti sulla scuola di Clavio"[42].

Given this background, it is fitting that we meet, among the suggestions prepared by Clavius for the mathematical section of the *Ratio Studiorum*, some advice derived from the world of navigation. In his *Method by Which Mathematical Disciplines Could be Promoted in the Schools of the Society*, Clavius makes explicit reference to natural philosophy. He explains that among the reasons for students to appreciate mathemat-

[41] On the relation between Clavius and Nunes see H. Leitão, *Pedro Nunes 1502-1578. Novas terras, novos mares e o que mays he: novo ceo nova estrellas* (Lisboa: Biblioteca Nacional, 2002), 16-27; J. Lattis, *Between Copernicus and Galileo. Christoph Clavius and the Collapse of Ptolemaic Cosmology* (Chicago and London: The University of Chicago Press, 1994), 15-18.

[42] U. Baldini, *Legem Impone Subactis. Studi su Filosofia e Scienza dei Gesuiti in Italia, 1540-1632* (Roma: Bulzoni, 1992), 243. The quotation is also reported in: Leitão, *Pedro Nunes*, 26.

ics must be cited its usefulness for the comprehension of the natural world[43]. Included in a list of natural phenomena for whose understanding and exploitation the school teaching of mathematics is most important, Clavius lists "the ebb and flow of sea tides; the winds; the comets; the rainbow, the halo [around the sun and the moon] and other meteorological events"[44]. It is worth noting that all these phenomena are directly related to transoceanic voyages.

Furthermore, in *The Order to Follow to Attain Proficiency in the Mathematical Disciplines*, written around 1581, Clavius recommends that tools and books from the world of navigation be employed in the teaching of mathematics[45]. For instance, he suggests the use of the Jacob's staff, also called a cross-staff, ‑used in navigation to measure angles for the purpose of determining latitude[46].

Among the books Clavius recommended for his educational program are several texts which later spread to many early modern European Jesuit schools. The first book Clavius endorses is his own *Commentary* on John Holywood's *De sphaera mundi*. Other notable texts on the list are Jemme Reinerszoon's *On the Separate Parts of the World*, Oronce Finé's *De Mundi Sphaera*, Peter Apian's *Cosmographicus Liber*, and Pedro Nunes's *De Crepusculis*. The absences from Clavius's list are also significant. There is, in fact, no mention of Ptolemy's *Geography*, although we do find his *Almagest*[47].

[43] The source can be found in C. Casalini-C. Pavur, S.J., *Jesuit Pedagogy 1540-1616: A Reader* (Boston: Institute of Jesuit Sources-Boston College, 2016), 291-294.

[44] *Ibid*., 292.

[45] *Ibid*., 283-288.

[46] *Ibid*., 284.

[47] *Ibid*., 286-287. All bibliographical references to ancient books can be found at the end of this article. On Reinerszoon, see R. W. Karrow,

These texts are important because they show the ways competing geographic and scientific ideas concerning the earth's conformation penetrated the Jesuit educational world. Thanks to a cordiform planisphere in Finé's *De mundi Sphaera*, for example, the idea of a *terra australis* was given widespread consideration. Vitally, this planisphere radically reduced the extension of the Pacific Ocean, accepting the Spanish imperial notion of a tameable sea according to the theory of the Amerasian continuity[48].

Image 2. Oronce Finé's cordiform planisphere (1536)

Returning to Clavius, his promotion of mathematics as way to understand natural phenomena related to the world of sailing reveals two things. First, scientific speculation was still driven by practical reasons. Com-

Mapmakers of the Sixteenth Century and Their Maps (Chicago: Speculum Orbis Press, 1993).

[48] On Finé's cordiform planisfere see Padrón, *The Indies of the Setting Sun*, 45-46, 76-78, and A. Santa Cruz, *Islario de Santa Cruz*, edited by Mariano Cuesta (Madrid: Real Sociedad Geográfica, 2003), 394.

pared to Dati's *Sfera*, which was conceived mainly for geographical orientation and commercial purposes, Clavius's arguments manifest a more theoretical, systemic, and unitary conception of the earth as a coherent system. While the *Sfera* merely aimed at helping with orientation, Clavius wants to lay the foundations for the understanding of nature.

Hence the second element: such references to navigation reveal how critical the technical progress underway in this field was in driving a conceptual shift in science. At this point it is important to emphasise that Clavius was by no means the only proponent of scientific mathematical studies. Different theoretical orientations on the premises of scientific study were in vigorous contention. Clavius's ideas, for instance, were opposed by Spanish Jesuit Benet Perera. In Perera's opinion, mathematical arguments lacked the logical force derived from a demonstration from true, material causes, while for Clavius the subject of mathematics is matter itself, since all mathematics is 'immersed' in matter[49].

Clavius has been described by historians as an excellent teacher and a brilliant mathematician, but also as a very conservative one. For Clavius, it has been written, mathematics was the mirror of a perfect, divine, and immutable world[50]. However, Clavius's approach to science betrays a profound awareness of a world that was quite different from the one described by ancient and biblical authorities. This is clearly shown in his *In Sphaeram Ioannis de Sacro Bosco Commentarius*, a

[49] On Benet Pereira and the controversy against Clavius see S. Higashi, *Penser les mathématiques au XVIe siècle* (Paris: Classiques Garnier, 2018), 354-360, C. Casalini, *Benet Perera and Early Jesuit Pedagogy. Human Knowledge, Freedom, Superstition* (Roma: Anicia, 2016); A. Alexander, *Infinitesimal: How a Dangerous Mathematical Theory Shaped the Modern World* (New York: Scientific American/Farrar, Straus-Giroux, 2014), 68-70.

[50] Alexander, *Infinitesimal*, 37.

book that would proliferate throughout all Jesuit schools in Europe[51].

Clavius's *Commentarius* mirrors what has been called a 'cosmographic revolution'[52]. Among its most revealing passages is an analysis of why the earth and the oceans form a single globe, clearly demonstrating the gradual emergence of a new way of making the world coherent[53]. Medieval theories, which were based on Aristotle's *De Coelo* (IV, 3) had imagined until then a world of concentric spheres of earth, water, air, and fire, where earth was placed in the centre and was partly submerged in water[54].

According to this system, the earth ought to be completely underwater. Medieval scholastics resolved this contradiction by reference to the idea that in a primordial moment of the creation, divine providence had moved part of the earth so that a portion of it protruded from the water. One supporter of this theory was Spanish bishop Jaime Pérez de Valencia. To better explain this configuration, Jaime evoked the image of an apple floating in the water, in which the irregularities of the top of the apple partially rise above the surface of the liquid[55].

Although before the fifteenth century some mathematicians and geographers disagreed with this theory, including the Persian Al-Farghānī, and the Europeans Albert the Great, Roger Bacon and Pierre d'Ailly, it was

[51] The edition consulted for this article is: Christophori Clavii Bambergensis, ex Societate Iesu, *In Sphaeram Ioannis de Sacro Bosco Commentarius* (Romae: ex Officina Basae, 1575), 123.

[52] See footnote n. 8.

[53] "An ex terra et aqua unus fiat globus, hoc est, an horum elementorum convexae superficies idem habeant centrum", *Commentarius*, 117-135.

[54] See Mammola, *Il problema della grandezza della terra*, 36-37.

[55] See J. Gil, "Los pasajes cosmográficos de los Comentarios a los Psalmos de Jaime Pérez de Valencia," *Mar Oceana: Revista del humanismo español y latino-americano*, II (1995): 262, and Padrón, *The Indies*, 52.

only with the rediscovery of Ptolemy that a new idea of the earth as a unique and integrated system was established. According to the new theories, the existence dry land was owed to the irregularity of the earth's contiguous spherical surface (instead of providential action)[56].

The definitive demotion of scholastic theories on the conformation of the world was only possible thanks to the oceanic voyages made by the Iberian kingdoms between the fifteenth and sixteenth centuries, whose importance in redefining cosmographic thought is explicitly expressed in Clavius's *Commentarius*. The German mathematician stresses the fact that the Portuguese and Spanish discoveries, by demonstrating the existence of unknown territories at the antipodes, had conclusively refuted the possibility that the only existing dry land corresponded to the ancient *Orbis Terrarum*, which posited a precise and tripartite point of land surrounded by water[57].

In addition, Clavius gives us a short and up-to-date summary of geography as he knew it: *per Africam, per Taprobanem, in Indijs orientalibus, per Insulas Moluccas, per Americae, sive nove Hispanie provinciam quae Peru nominator,* suggesting that his position on the debate over American insularity versus Amerasian continuity was in favor of the latter[58].

In terms of his other scientific observations based on transoceanic navigation, the Jesuit argues against the

[56] Jaime Pérez himself, as he explains in his 1484 *Commentaria in Psalmos*, adhered to the new Ptolemaic theory. See W. G. L. Randles, *Classical Models of World Geography and Their Transformation Following the Discovery of America*, in *Geography, Cartography and Nautical Science in the Renaissance: The Impact of the Great Discoveries* (Aldershot-Burlington, Ashgate-Variorum 2000), 41 and Padrón (2020), 52.

[57] *Commentarius*, 126: "Experientia autem quotidiana Lusitanorum Hispanorumque satis nos edocet terrae huic habitabili multos assignari antipodes"; "Hodierne navigantium experientiae". Cfr. Mammola, 35, 37.

[58] *Ibidem*.

hypothesis that water swelled away from the land. He reports the fact that equal angular distances correspond to equal distances both on the sea and on land. Again, he emphasizes the fact that in places located on the same parallel, at 15 degrees' distance we see the sunrise with a one-hour difference[59].

These examples are but a few from the educational program prepared by Clavius – a curriculum that would spread throughout early modern Europe. It is now possible to grasp the profound link between the world of Iberian oceanic navigation and the new cosmography taught and produced in Jesuit colleges. Although Clavius's mathematical program had not been fully integrated into the *Ratio Studiorum*, his role should not be seen only as a strong promoter of a certain way of doing mathematics. Clavius's thought must be seen as emblematic of a broader trend in Jesuit pedagogy marked by increased scientific and geographical teaching.

End of Part I

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Intentionally limited to published primary sources. Full modern bibliography will be provided with the Part II of this article.

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[59] See Mammola, 37-38.

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