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"To find God in all things": the meeting of faith and mathematics in Jesuit education during the scientific revolution

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Resumo

É bem conhecido e aceito que o início da tradição matemática dos jesuítas se deve a Christopher Clavius, professor de Matemática no Colégio Romano entre 1567 e 1595. Neste artigo, questiona-se: Quais eram os aspectos sociais, políticos, filosóficos, e as razões religiosas que levaram Clavius a criar um currículo educacional inovador que incluiu o ensino de matemática nas faculdades jesuítas? Para responder à esta pergunta, olhamos para os primeiros anos da Companhia de Jesus considerando o contexto histórico e uma análise de como o aprendizado matemático interagiu com a doutrina Católica.

***Palavras-chave**: Pedagogia Jesuítica; Ciência e Fé; Igreja e ciência*

Abstract

It is well known and accepted that the beginning of the mathematical tradition of the Jesuits is due to Christopher Clavius, professor of Mathematics in the Roman College between 1567 and 1595. In this article, the question is: What were the social, political, philosophical, and religious reasons that lead Clavius to create an innovative educational curriculum that included the teaching of mathematics in the Jesuit colleges? To answer this question, we look at the early years of the Society of Jesus considering the historical context and an analysis of how mathematic learning interacted with the Catholic doctrine.

***Keywords**: Jesuit pedagogy; science and faith; Church and science*

1. CATHOLICISM AND MATHEMATICS

The myth that the Catholic Church opposed science and that Catholics themselves contributed little to scientific development is still widespread and persistent in modern social imagery.[1] The historian Herbert Butterfield warned against the danger of what he called "the Whig interpretation of history". He defined it as "the tendency in many historians to write on the side of Protestants and Whigs, to praise revolutions provided they have been successful, to emphasize certain principles of progress in the past and to produce a story which is the ratification if not the glorification of the present".[2] However, many historical records and new historiographic research has been deconstructing such myths and demonstrating the importance of the Catholic church in the history of scientific development, including in the so-called "Scientific Revolution"

[1] Sheila J. Rabin, "Early Modern Jesuit Science. A Historiographical Essay," *Journal of Jesuit Studies* 1, no. 1 (2014): 88–104, https://doi.org/10.1163/22141332-00101006.
[2] Rabin.

period in which many Catholics and several Catholic institutions played key roles in the rise of modern science.[3] Among them, the Society of Jesus has been acknowledged as an important contributor to scientific advancement in early modern times, notably in mathematics.[4]

The meeting between Catholic faith and mathematics goes back centuries, being present in Saint Augustin's works and those of other Fathers of the Church. Nevertheless, the interest in the phenomenon of Catholicism and mathematics interaction in the Scientific Revolution did not receive much attention until after the pioneering works of Henri Bosmans and, in 1950, the work of François de Dainville on mathematics and the Jesuits. In the early modern period, several Roman Catholic clergymen and theologians, not all of them Jesuits, showed a strong interest in mathematics.[5] Some of them were renowned mathematicians, others were philosophers or authors of textbooks on mathematical sciences that helped disseminate knowledge related to the field. Examples include the following: Jesuit Christopher Clavius (1538–1612), Jesuit André Tacquet (1612–1660), Jesuit Gregoire de Saint Vincent (1584–1667), Jesuit Paul Guldin (1577–1643), Minim Marin Mersenne (1588–1648), Jansenist Antoine Arnauld (1612–1694), Oratorian Nicolas Malebranche (1638–1715), Oratorian Bernard Lamy (1640–1715), and Oratorian Charles René.

A common error among those less familiar with the Catholic Church is the idea of the Catholic church as an entity that is monolithic, homogenous, or unanimous, ignoring that the several individuals and groups who compose it often hold widely divergent viewpoints. The fact is that the Catholic Church has interacted with many philosophical and scientific currents along its two thousand years yielding several debates, refusals, assimilations, and adaptations of many new ideas and theories, including Aristotelian, atomism, heliocentrism, Darwinism, polygenism, and geological chronology.[6] Such interactions have involved several social, political, historical, and economic aspects that do not fit reducible and simplistic historical explanations. The same is true when dealing with the interaction between mathematics and Catholicism. From the beginning of the Catholic Church to its modern times, and from Saint Augustin to Pascal, Mersenne, and the modern Catholic philosophers, several debates about epistemological meanings and the importance of mathematics and its relationship with Catholic doctrine have been raised. While in the Early Catholic Church, both Pythagorean and Platonic philosophies predominated, the Middle Age Catholic Church began to adhere to Aristotelian philosophy during the Renaissance of the XII century, adapting it to Catholic doctrine.[7] The emergence of Cathedrals stablished the medieval science as an important bridge

[3] M. Principe Lawrence, "That Catholics Did Not Contribute to the Scientific Revolution," in *Galileo Goes to Jail and Other Myths about Science and Religion*, 2009.
[4] Gérard Chauvin, *Petite histoire des jésuites* (Versailles: Ed. de Paris, 2008).
[5] Jorge A. Molina, "Catholicism and Mathematics in the Early Modernity," in *Interfaces between Mathematical Practices and Mathematical Education.G.Schubring(Ed).*, 2018.
[6] Georges Minois, *L' Eglise et la science: histoire d'un malentendu 1 1* (Paris: Fayard, 1990).
[7] Lawrence, "That Catholics Did Not Contribute to the Scientific Revolution."

between the classical Greek tradition, Muslim contributions and modern science.[8] This tradition provided medieval scholars with written texts that offered both a sophisticated account of the cosmos and a methodology for its further investigation.[9] Thus, during the Scientific Revolution, a myriad of new ideas, philosophic and scientific innovations, and the rescue of ancient Greek knowledge all cohabited with traditional knowledge, which led to an exuberant and complex period. Plato and Pythagoras' thoughts were revived, updated, and extended, influencing the conception of mathematics as a discipline.[10]

We note different perceptions throughout this time period and even in a single period from many different Catholic philosophers and mathematicians, as is the case in the early modern times. For Saint Augustine, the study of the nature of numbers could be a valuable theological tool to interpret the Holy Scriptures. Influenced by Pythagoras and Plato's philosophy, he claimed that numbers make up part of the essence of the World Created by God. Thus, he specifically referred to arithmetic saying that the objects with which this science deals are not creations of human minds but rather discoveries of human minds:[11]

> "As for the science of numbers, it is obvious to the least enlightened mind that it is not the result of human discoveries, as soon as we have discovered or read it in nature; no one can make three times three not nine, not a square. Numbers will always have the immutable laws which were not invented by man, but simply discovered by the insight of scholars."

> "God, therefore, accomplished the works of His creation in six days, a perfect number of days. For thus it is written: And on the sixth day God finished the works He bad made. And I am even more intrigued by this number when I consider the order of the works of creation. For they are ordered like the number six itself, which rises in three steps from its parts. One, two, and three follow in order, without the possibility of any other number being inserted; and these are the parts of which six is com posed, one being a sixth, two being a third, and three being a half."

Centuries later, during the Scientific Revolution, many reflections flourished concerning the purposes of studying mathematics. Father Lamy wrote that mathematics is also useful for leading to the acceptance of

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[8] David C. Lindberg and Michael H. Shank, *The Cambridge History of Science*, 1st ed. (Cambridge University Press, 2013), https://doi.org/10.1017/CHO9780511974007.
[9] Lindberg and Shank.
[10] Lawrence Principe, *The Scientific Revolution: A Very Short Introduction*, Very Short Introductions 266 (Oxford ; New York: Oxford University Press, 2011); Steven Shapin, *The Scientific Revolution* (Chicago, IL: University of Chicago Press, 1996).
[11] Augustine and John Hammond Taylor, *The Literal Meaning of Genesis*, Ancient Christian Writers, no. 41-42 (New York, N.Y: Newman Press, 1982).

Catholic moral theology. In his Éléments des mathématiques ou traité de la grandeur en général (1680), Lamy wrote[12]:

> "One of the great principles of human evil is this strong inclination people have for things that are perceivable, which means that nothing pleases them other than that which flatters their senses. Thus as geometry separates from the bodies it studies all perceivable qualities and leaves them nothing which can please the concupiscence, when one can dedicate one's spirit to the study of this science, one detaches it from the senses and comes to love other pleasures than those who taste it by the means of senses" [Molina[13] translation].

Another motivation for the study of mathematics by clergymen is its use in defending the Christian faith. Father Bernard Lamy expressed in the preface to his book entitled "Traité de la grandeur en général," published in 1680, that mathematics helps us conceive spiritual realities because it detaches the mind from the things perceived by the senses and then helps us conceive of spirituals and abstract things. Moreover, Lamy said that the mathematical sciences teach us both the extension and limits of our minds. Referring to the content of his book, in the preface, Lamy said:[14]

> "This treatise reveals the extension of our mind and its limits. For there are demonstrations that clearly and convincingly prove that a finite magnitude is infinitely divisible and that there are truths, which are certain but for us incomprehensible. Consequently, the truths that religion teaches us must not be suspected though they are for us incomprehensible" [Molina[15] translation]. (Lamy 1765, xxi).

The Jesuits thought that mathematics could be useful to missionaries, especially the disciplines that were considered to belong to applied mathematics at the time, such as astronomy and geography.[16] This knowledge was necessary for navigation and other activities related to the task of evangelization. Furthermore, the intellectual elites of Eastern Asia were much interested in all mathematical disciplines.[17] The intellectual interchange involving mathematics and science was considered a helpful bridge to

[12] Molina, "Catholicism and Mathematics in the Early Modernity."
[13] Molina.
[14] Molina.
[15] Molina.
[16] Michela Fontana, *Matteo Ricci: un jésuite à la cour des Ming : 1552-1610*, 2019.
[17] Rabin, "Early Modern Jesuit Science. A Historiographical Essay."

missionaries trying to get close to these regions and cultures and to create propitious grounds to present Christianity.[18]

Taking account of the brief discussion presented above, some historians argue that the value of mathematical sciences for the education of clergymen does not lie in any institutional decision made by the Roman Catholic Church and its religious orders. Instead, the main reason for education is that mathematics could be useful for accepting the mysteries of Christian faith or useful to theology for defending and understanding certain philosophical conceptions.[19] Many other reasons could be listed here, but what is evident that there is not a simplistic and straightforward explanation of the relationship between mathematics and Catholicism. Such propositions risk being seen as unrealistic or, at least, as a distorted account.

Thus, this article aims to focus on a smaller aspect of this long history between mathematics and Catholicism: the prominent place of mathematics in Jesuit education and its importance for advances in the history of this discipline.[20] It is well known and accepted that the beginning of this mathematical tradition of Jesuits is due to Christopher Clavius, professor of Mathematics in the Roman College between 1567 and 1595.[21] In this brief article, the question to be answered is: What were the social, political, and religious reasons that lead Clavius to contribute to setting up an innovative educational curriculum that included the teaching of mathematics in the Jesuit colleges? To answer this question, we have to look at the early years of the Jesuit Order.

2. THE RATIO STUDIORUM ORIGINS

The Society of Jesus is a religious order of the Catholic Church founded by Saint Ignatius of Loyola and approved by Pope Paul III in 1540. As an order born of the Counter-Reformation, it aims to form members of a high intellectual level, capable of defending the Christian faith and performing a missionary apostolate in the New World.[22] Debates over the churches' division, the emergence of new intellectual demands expressed by humanism, and amplification of the movement of ideas promoted by print contributed to undermining the foundations of the medieval university, thus leaving room for new educational projects or educational experiences.[23]

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[18] Fontana, *Matteo Ricci*.
[19] Molina, "Catholicism and Mathematics in the Early Modernity."
[20] Antonella Romano, *La Contre-Réforme Mathématique: Constitution et Diffusion d'une Culture Mathématique Jésuite à La Renaissance (1540-1640)*, Bibliothèque Des Écoles Françaises d'Athènes et de Rome, fasc. 306 (Rome: Ecole française de Rome, 1999).
[21] Romano.
[22] Chauvin, *Petite histoire des jésuites*.
[23] Price Audrey, "Mathematics and Mission: Deciding the Role of Mathematics in the Jesuit Curriculum," *Jefferson Journal of Science and Culture*, 2016.

As soon as its creation, the Society of Jesus began to get involved in the problem of education, starting with the training of its members who had not had sufficient studies. In 1544, there were seven colleges or residences for Jesuit students near the universities of Paris, Louvain, Cologne, Padua, Alcalá de Henares, Valencia, and Coimbra. A few years later, Jesuits began to establish their institutions, taking charge of teaching and accepting non-Jesuit students. In 1542—the order was less than two years old—, François Xavier wrote from Goa, India, intermediating the interest of the Portuguese governor Martin Alfonso de Souza in asking the King of Portugal to send Jesuits to teach grammar for the sixty novices of a very young seminary. Four years later, in Gandia, the second Jesuit experience was initiated at the request of Duke Francisco de Borgia: unlike the previous one, it involved Jesuits in the field of philosophical studies. These first two examples illustrate social and political aspects in the requirement of reliable places and efficient interlocutors for the training of elites. Within a short period, the Jesuit colleges would become prestigious establishments that corresponded well with the new demands of European aristocracies and princes of the Church and with new possibilities of careers and vocation for the less fortunate.[24]

The great success of the first Jesuit schools was due in part to a new orientation in teaching based on the method followed in the university of Paris, *the modus parisiensis*, and the use of programs adapted to the times.[25] The Jesuits emphasized the order and discipline to be followed in their teaching and the ordered distribution of classes according to the needs and capacities of the students. Repetitions and disputations were common exercises practiced by the students to complement professorial lectures. Jesuits also took charge of universities with full courses of philosophy and theology. To obtain university status, schools needed a Papal or Royal decree, which granted them the right to award academic degrees. The Roman College had university rank from 1584, and among the first Jesuit universities were those of Gandía, Messina, Coimbra, Palermo, Vienna, and Prague. The network of Jesuit schools and universities spread rapidly through Europe, and there were about 625 of them in the eighteenth century. Jesuits also established colleges and universities in America, India, and the Philippines.[26]

To achieve the initial goals of the order he had proposed, St. Ignatius decided to centralize and standardize the organization of the order, writing the votes, rules, guidelines, and recommendations of the Jesuits in the Constitutions.[27] Accompanying this document, St. Ignatius elaborated a spiritual guide, namely "spiritual exercises," which should encompass all the activities of Jesuits. His main principle became the unofficial Jesuit motto: *Ad Maiorem Dei Gloriam* ("For the greater glory of God"). Saint Ignatius wanted his

[24] Audrey.
[25] Agustin Udias, *Jesuit Contribution to Science: A History* (New York: Springer, 2014).
[26] Udias.
[27] Romano, *La Contre-Réforme Mathématique*.

companions to have control over themselves and be men of character. Moreover, he argued that moral education is the end to which they first intend to arrive and to which they converge all the means at his fingertips.[28] Therefore, the Jesuit schools form men of character who are predominantly Christian, since St. Ignatius was convinced that instruction without religious education was a danger to society. In both *Constitutions* and *spiritual exercises*, a humanist aspect is an essential ingredient of curricula in Jesuit education—it is salient in the Exercises in its existential thrust. Fifteenth-century Jesuits were cultivating the dynamism of the Spiritual Exercises crafted by Ignatius, a Renaissance humanist educator, by focusing more on the realities and complexities of daily life than on speculative truths.[29] Another important aspect is the idea that any work that is not evil can be meritorious for the spiritual life if it is performed with this intention, even things that are customarily considered of little importance. The first official mention of teaching mathematics in Jesuit schools is found in *the Constitutions*, written by Saint Ignatius, in which he treats about the subjects to be taught in the Jesuit universities and says : "there must be taught logic, physics, metaphysics and moral theology and also mathematics, with the due moderation for the end that is intended" and, with reference to the professors, says: "There should be some professors who as public lecturers read philosophy or mathematics." In 1548, Jerónimo Nadal (1507–1580), a collaborator of Saint Ignatius, proposed classes in mathematics and astronomy for the programs of the College of Messina, with specific mention of geometry, arithmetic, astronomy (sphaera), and the theory of the astrolabe and the planets.[30]

Given the increasingly significant demands of external students and teachers' lack of experience, there was a need to standardize the methodology of work in the schools.[31] Thus, a commission of prominent Jesuits codified *the Ratio atque Institutio Studiorum Societatis Jesu,known* as the *Ratio Studiorum*. The document was submitted to various analyses and amendments until it became definitive and obligatory in 1599 after 15 years of detailed studies. The heart of the order was to guarantee the uniformity of procedures, mind, and heart of Jesuit educators and students for the achievement of the proposed objectives, namely opposing the turbulence unleashed by the reformist movement of the 16th century (Romano, 1999). In short, the purpose of the Society of Jesus is to provide a broad kind of discipline to bring its members to the knowledge and love of the Creator Jesus Christ (Hendrickson, 2012). In Jesuit pedagogy, instruction and education progress together. Education is not merely used to promote the religion but as a way of providing the full realization of human nature (Hendrickson, 2012).

Programs in Jesuit schools covered three cycles, grammar (humanities), philosophy, and theology, but not every school had all three. Most of the schools resembled today's secondary schools, with programs

[28] Romano.
[29] Romano.
[30] Romano.
[31] Audrey, "Mathematics and Mission: Deciding the Role of Mathematics in the Jesuit Curriculum."

in humanities and some elements of philosophy and theology. Only in those considered as major colleges were there complete programs of philosophy and theology. Each cycle lasted, in general, three years, though in some cases philosophy was reduced to two years and, for Jesuit students, theology extended to four years. The first cycle comprised the humanities with an emphasis on the mastery of languages, especially with the study of the Latin and Greek classics. The three years dedicated to philosophy included logic, physics, and metaphysics, though programs varied in different schools (Chauvin, 2008; Hendrickson, 2012; Romano, 1999).

3. CHRISTOPHER CLAVIUS AND THE INSERTION OF MATHEMATICS IN THE *RATIO STUDIORUM*

The mathematical tradition of the Society of Jesus begins with Christopher Clavius (1537–1612), a great mathematician, astronomer, and Jesuit teacher who was born in Bamberg, Germany and had a particular interest in mathematics in the Society.[32] It is necessary to contextualize the debates about mathematics in the early modern times to understand their role in the insertion of mathematics in *the Ratio Studiorum.*

The problem concerning mathematics—which had already been raised by medieval philosophers—was its relation to natural philosophy. Aristotle had made it clear that mathematics did not belong to natural philosophy since it deals only with the quantifiable aspects of things and not with things themselves. For him, mathematical knowledge, unlike that of physics, is based on the imagination and not on the senses. In general, scholastic philosophers shared Aristotle's view that the abstract aspects of mathematics placed it outside of what was considered true science, that is, a knowledge related to real things.[33]

As influential voices in this period, Bacon and Boyle kept a skeptical position about the legitimacy of the world's mathematical structure. Boyle claimed that mathematical accounts worked very well when its nature was dealt with abstractly but less well when it was addressed to concrete particularities.[34] However, with the emergence of the Renaissance and the rescue of the Greek tradition, modern natural philosophers turned to Pythagoras and Plato to legitimate the mathematical treatment of the world, quoting Plato's dictum that "the world was God's epistle written to mankind" and that "it was written in mathematical letters." Later, Galileo argued that natural philosophy ought to be mathematical in form because nature was mathematical in structure.[35] Kepler discovered that the structure of the planetary system followed a geometrical order and considered the reason it did so: "God, creating the universe and regulating the order of the cosmos, had in view the five regular bodies of geometry as known since the days of Pythagoras and Plato, and… He has

[32] Udias, *Jesuit Contribution to Science*.
[33] Udias.
[34] Shapin, *The Scientific Revolution*.
[35] Shapin.

fixed, according to those dimensions, the number of heaves, their proportions, and the relations of their movements".[36] A mathematically inclined astronomer had discovered that the Creator God was a mathematician, whom had employed the principles of geometry to lay out planetary distances. The mathematical harmony of the spheres was a substantive feature to govern the motions of the world created by God. Nature obeys mathematical laws because God had used these laws in creating nature. As investigators of physical phenomena, practitioners worked with, and tried to make sense of, real sensible, physical evidence; as mathematicians, they sought to establish the formal patterns that underlay, and may have given rise to, the natural world.[37] This debate was also taking place between Jesuits: with professors of philosophy on one side and those of mathematics on the other, both with firm convictions. Benito Perera (1535–1610), who taught philosophy between 1558 and 1567 and theology until 1597, was prominent among the professors of philosophy in the Roman College who were against considering mathematics as a true science.[38] His position was clear: mathematics is not science because it does not have true demonstrations and because it abstracts from consideration of "being" and "goodness." He held that, according to Aristotle, science is knowledge acquired through causes, and this is not the case in mathematics. In opposition, the mathematician Francesco Barozzi, in a book published in 1560 on certitude in mathematics, took a position in favor of the truly scientific character of mathematics based on arguments from the Greek mathematician, Proclus. Vicenzo Figliucci (1566–1622), a professor at the College of Naples, took a more extreme position, pretending to develop a "theology of mathematics." Following Neoplatonic ideas, he proposed that mathematics has been put by God in the human mind so that through it man can understand the world of nature.[39]

In turn, Clavius based his opinions on the prologue written by Proclus to the books of Euclid that was influenced by the ideas of the Neoplatonic philosopher Plotinus and based on the considerations of Barozzi. Clavius criticized that there were many and different interpretations of the doctrine of Aristotle, but the demonstrations of Euclid's geometry always inspired the same certitude and truth. The critics of Clavius suggested the superiority of geometry over natural philosophy.[40] According to Clavius, mathematics should occupy the first place if we rank sciences according to their degree of certitude, since its certainty is superior to the uncertainties of natural philosophy, as demonstrated by geometry. Moreover, geometry knowledge could be applied as well to all applications of mathematics to explain natural phenomena and the universe itself in its totality since it was geometrically designed by God.[41] In this way, geometry provided for Clavius

[36] Shapin.
[37] Shapin.
[38] Udias, *Jesuit Contribution to Science*.
[39] Udias.
[40] Udias.
[41] Romano, *La Contre-Réforme Mathématique*.

knowledge of the structure and working of the natural world, belonging to the field of the natural sciences. He even asserted that mathematics is not only useful but necessary in metaphysics since, quoting Plato, it directs the mind to the contemplation of the divine. He also used the testimony of the Holy Fathers of the Church, such as Augustine, Jerome, Gregory of Nyssa, and Basil. For example, Clavius quotes St. Augustine's remark that mathematical disciplines can help to interpret Sacred Scripture.[42] Finally, he demanded that professors of philosophy forbear from saying that mathematics is not a science, nor talk or write against the usefulness of mathematics, as it seems that some professors sometimes did. All these recommendations were aimed to give mathematics equal importance to that given to natural philosophy in the teaching of philosophy. Such an attitude implied an innovation in the programs for philosophy, contributing to establish the emergent modern science grounded in mathematical formulations and experimental approaches.[43]

In the text of the first version of the Ratio in 1586, Clavius' influence is undeniable in one of the chapters entitled *De mathematicis*. There is a recommendation to study mathematics, as "without them, our entire academic program will be sadly depleted," and a mention of the practical utility of mathematics for society in general and the Church. *The Ratio* document stipulates that in the second year of philosophy, the Elements of Euclid should be taught, along with geography and astronomy. Due to the lack of good professors of mathematics, a special three-year program was proposed to train a small group of young Jesuits (those with the right talents) from different provinces.[44] Clavius' strong advocacy in favor of the inclusion of mathematics in the Jesuit curriculum can be observed in various of his works written between 1580 and 1593: *Ordo servandus in addiscendis disciplinis mathematicis* (Order to be followed in teaching mathematical disciplines), *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri* (Ways to promote mathematical disciplines in the schools of the society) and De Mathematica instructio (Instruction about mathematics).[45] After 1580, Clavius and the various editorial bodies of *the Ratio* established constant dialogue and, finally, in the last version of *Ratio Studiorum*, the question of the inclusion of mathematics teaching received a favorable decision, although there were opposing proposals. The final normative text presents reflections inspired by several mathematic masters and marks Clavius' influence in the Ratio writing process. This pioneering role played by some members of the Society of Jesus in the definition of a new status for mathematics would reflect in new ways of organizing scholarly curriculums and opening new educational practices.[46] This controversy about the "certainty of mathematics" is important and cannot be ignored because mathematical formulation is precisely one of the characteristics of modern science, together

[42] Udias, *Jesuit Contribution to Science*.
[43] Udias.
[44] Romano, *La Contre-Réforme Mathématique*.
[45] Udias, *Jesuit Contribution to Science*.
[46] Romano, *La Contre-Réforme Mathématique*.

with reliance upon observations and experiments. The insistence of Clavius on the importance of teaching mathematics, which was finally accepted in *the Ratio* as normative for all Jesuit schools, put mathematics in line with the new developments of science. Consequently, we will find the Jesuit contributions to modern science coming from the professors of mathematics, not from the professors of natural philosophy, who remained stuck for a long time in Aristotelian physics. Jesuit professors of mathematics often crossed the boundary between mathematics and natural philosophy to validate their conclusions about the nature of things. For example, astronomy was for them not only a mathematical instrument to predict the position of the heavenly bodies but could also provide knowledge about their nature. In this sense, Clavius was a pioneer in the view that mathematical sciences really belong to the natural sciences. He even asserted that mathematics is not only useful but necessary in metaphysics since, quoting Plato, it directs the mind to the contemplation of the divine.

The utility of mathematics was also a source of leverage in the pursuit of patronage everywhere the Jesuits went.[47] Practical branches of mathematics were not limited to arithmetic. In the sixteenth century, mathematics included a wide variety of applied studies. Telling time, measuring and mapping land, constructing new buildings or irrigation systems, perspective and optics, and using astrology for medicine and meteorology fell under the umbrella of mathematics.[48] Indeed, as Romano has shown, the mathematics the Jesuits taught in France depended on what the locality of any given school felt was necessary for its development. This meant that French schools might have taught branches of mathematics like hydrography to establish irrigation systems or fortifications to improve the protection of their cities.[49] Once a Jesuit school was in place, much more than mathematics was taught. Latin, natural and moral philosophy, and theology all had a place in the Jesuit curriculum. Mathematics was just one part of the education of Catholic leaders and citizens.[50]

4. Final considerations

A school system was not the primary goal for the original Jesuits. However, the Jesuit colleges became, already during Saint Ignatius's life, the most crucial instrument of the apostolic work of the Order. This contingency educational plan resulted from a complex combination of circumstances: the troubled social and political background of the XVI century involving Protestantism and counter-reform; the new philosophical ideas boosted by print and circulating in an emergent bourgeoisie; and the discovery of new continents opening new economic, social, and religious perspectives. The spirituality and values of Ignatius

[47] Audrey, "Mathematics and Mission: Deciding the Role of Mathematics in the Jesuit Curriculum."
[48] Fontana, *Matteo Ricci*.
[49] Audrey, "Mathematics and Mission: Deciding the Role of Mathematics in the Jesuit Curriculum."
[50] Udias, *Jesuit Contribution to Science*.

and the early Jesuits marked the schools they founded. Grounded in a spirituality that seeks to "find God in all things," the pedagogical approach of Jesuit schools emphasizes a personal development of nature and the fulness of human living. St. Ignatius believed that individuals, through a better understanding of the world, could think and develop a more robust vision of it, creating new ways of acting. He understood this integral connection between knowing and acting and hoped that Jesuits and the graduates of their schools would become "contemplatives in action."

There was no activity, no matter how profane it may have looked, that could not be transformed into prayer. Teaching mathematics or physics in a university, observing the light from a distant galaxy, or drawing a map of an unknown region were activities that a Jesuit found perfectly compatible with his vocation. Through these, it is possible to find God in his life. In other religious groups, this may become a personal attitude but for Jesuits, it stems from the core of their spirituality. Angelo Secchi, the renowned astrophysicist, acknowledged this by saying: "The contemplation of God's works is one of the noblest works of the spirit; this is the principal aim of the study of nature." Thus, Jesuits involve themselves in activities, among them scientific research, which others consider incompatible or at least not suitable for religion. We find Jesuits active in social work and as parish pastors, but also carrying out research in biology or astrophysics, or writing poetry, all motivated by the same spirituality of "seeking God in all things" …for the greater glory of God.

The Ratio Studiorum developed by the Jesuits at the end of the sixteenth century offered a mathematics curriculum that was unusual for its time in that it left open the possibility of teaching mathematics and its practical branches. The decision to teach this discipline was not unanimous. It was widely debated among Jesuits and reflected the philosophical questions concerning the certainty of mathematics and the real world. Not only mathematics but all educational projects proposed by the leaders of the Society of Jesus, notably St. Ignatius and C. Clavius, were strictly connected with the Scientific Revolution paradigms. The Society of Jesus and its educational tradition was not a closed hermetic phenomenon but an interaction between a genuine faith of devoted men with new philosophical, spiritual, social, and scientific ideas circulated in the early modern times. Thus, the members of the Society of Jesus marked the history with a unique and original fingerprint, renewing the spirituality of the Catholic faith and opening new horizons to mathematics research.

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