Mathematics and Mission: Deciding the Role of Mathematics in the Jesuit Curriculum

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Abstract

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 practical branches of mathematics. The learned theologians, philosophers, and mathematicians who were members of the Society of Jesus valued mathematics, especially astronomy, for its connections to theology, but they could not ignore the necessity of the engineering skills provided by a practical mathematics education. Practical mathematics held appeal for missionaries and heads of state both in and outside of Europe and served to help the Jesuits gain patronage. Therefore, the Jesuit curriculum provided an opportunity for schools to teach mathematics as a higher faculty, along with philosophy, but left it up to the individual schools whether astronomy or another more practical branch of philosophy should be taught.

In 1599, 245 Jesuit schools received the third and final version of the *Ratio Studiorum*. After nearly sixty years of teaching, and nearly twenty years of developing a curriculum, the Jesuits had settled on the final version of their curriculum. The *Ratio Studiorum* contained instruction on how to run the schools and what should be taught when. There were rules for everyone from the head of the school to the teachers of each subject and even the students.[1] The priests assigned to teach mathematics found themselves with only three guiding rules. Of those, only the first rule provided guidelines on what to teach. Euclidean geometry was the only required subject. For two months the mathematics students would study Euclid's *Elements* exclusively. After that the instructor would add another topic. According to the curriculum, instructors could "add some geography or astronomy or similar matter which the students enjoy hearing about."[2] This left the curriculum open to whatever the teacher or the school felt was most important for the students to learn. As it turned out, even though most institutions of higher education in the seventeenth century taught astronomy because it was seen as the most noble branch of mathematics, the Jesuits outside of the Roman center took advantage of the open-ended nature of their curriculum and were more likely to teach geography than astronomy, clearly favoring practical branches of mathematics over the theoretical questions found in astronomy.[3] Why did the Jesuits

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[1] The 1599 *Ratio Studiorum* was the third official draft of the curriculum. The first two had been sent out to all the provinces in 1586 and 1591 for revision. The final curriculum was truly the product of an Order-wide collaborative effort. I have based my work on Allan Farrell's 1970 translation of the *Ratio Studiorum.*

[2] Allan Farrell, trans. *The Jesuit Ratio Studiorum of 1599* (Washington DC: Conference of Major Superiors of Jesuits, 1970), 46.

[3] Antonella Romano, *La Contre-Reforme Mathematique: Constitution et Diffusion D'une Culture Mathematique* (Rome: Ecole Francaise de Rome, 1999). Romano only studies the French colleges as a case study of the relationship between Rome and the periphery. Her argument shows that the French colleges valued local requests for practical topics over Rome's suggestion to emphasize astronomy at least in part to maintain patronage. Since Jesuits were often invited into communities by the merchant class or nobles seeking to improve the quality of their holdings, practical mathematics was appealing for its ability to provide the local boys with useful skills. Jesuits around Europe faced similar challenges to maintaining patronage. It seems quite probable that they would have used practical mathematics in similar ways to gain and maintain patronage.

set up their mathematics curriculum to allow most of their schools to teach unconventional, albeit practical, mathematical topics?

To answer that question we have to look at the early years of the Jesuit Order. A school system was not the goal for the original Jesuits. The founding members of the Society, led by Ignatius Loyola, hoped to create a missionary group to support Christianity in the Holy Land. However, in the 1540 Bull of Institution, Pope Paul III asked the new religious order to support the faith at home in Europe where Protestant religions were rapidly growing. A new order of educated Catholic preachers would strengthen and support the Catholic Reformation. The Papal Bull said that the Order was "a society principally instituted to work for the advancement of souls in Christian life and doctrine, and for the propagation of the faith by public preaching and the ministry of God's Word, by spiritual exercise and works of charity, *more particularly by grounding boys and unlettered persons in Christianity.*" Members were to strive for "above all things...the instruction of boys and ignorant persons in the knowledge of Christian doctrine, the Ten Commandments, *and other such rudiments as shall be suitable.*"[4] The Jesuits interpreted the phrase on "grounding boys and unlettered persons" in Christianity as an exhortation to teach, and believed the other suitable rudiments were grammar and rhetoric. When they deemed it appropriate to offer more

[4] "The Bull of Institution, 1540," in *The Catholic Reformation: Savonarola to Ignatius Loyola*, ed. John Olin (New York: Fordham University Press, 1992), 201-208. Emphasis is mine.

advanced education, which usually meant when preparing a novice to join the order, the Jesuits added philosophy and advanced lessons in theology.

Once their focus had been directed away from the Holy Land, the Jesuits quickly devoted themselves to education as a missionary activity. The schools were to help the Society, the students, and the localities in which they were located by creating good Catholic citizens and, of course, more Jesuits. While Jesuits had been teaching at various institutions since the Society's inception in 1540, the first wholly Jesuit-run school was founded in 1546 in Gandia, Spain under the patronage of the local duke who later joined the order himself.[5] The next two schools, founded in Messina and Palermo, Sicily, a short two years after the one in Gandia, were requested by local officials, not nobility. Since Jesuit schools provided a free education, communities often welcomed them. The requests for schools continued and in 30 years, the Jesuits had opened 150 schools. In fifty years, the number was up to 245, including a few in India, China, and the Americas.[6]

Even in their earliest curricula, mathematics played a significant role. It is not clear why mathematics was such a dominant part of the early curricula, but it is

[5] John W. O'Malley, *The First Jesuits* (Cambridge, MA: Harvard University Press, 1993), 202-203.
The duke requested special permission to set up a school in Gandia where there was not an already existing university. Without an institution to attach themselves to, the Jesuits found themselves teaching every subject to all students, including students who would not go on to join the Order.
[6] Farrell, iii.

probable that mathematics gave the Jesuits an edge over other educators.[7] Mathematics was not generally taught in lower level Latin schools, but because of its utility, it was in high demand, especially in communities which invited the Jesuits to educate the sons of the merchant class, not just sons of the nobility. Vernacular schools did include abacus schools which taught practical arithmetic primarily to sons of merchants.[8] However, those schools did not teach Latin, still a necessary language to be considered well-educated in the mid-sixteenth century. By including mathematics in their Latin curriculum, the Jesuits offered the best of both worlds, and their early curricula did include practical arithmetic, which supports the theory that they were competing with the abacus schools.

The utility of mathematics was also a source of leverage in the pursuit of patronage everywhere the Jesuits went. 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. Indeed, as Romano has shown, the

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[7] Jerome Nadal was the architect behind the original mathematics curriculum in Jesuit schools. Romano believes that he was aware of the competitive edge mathematics gave Jesuit schools and, therefore, used his own substantial mathematics education to create a curriculum in which mathematics was treated as a branch of philosophy rather than as a lower discipline. See Romano, 47-49.

[8] Paul Grendler, *Schooling in Renaissance Italy: Literacy and Learning 1300-1600* (Baltimore: The Johns Hopkins University Press, 1989), 306-309. Some also taught surveyor's geometry. See JV Field, *The Invention of Infinity* (Oxford: Oxford University Press, 1997).

mathematics the Jesuits taught in France depended on what the locality of any given school felt was necessary for its development. That meant French schools might have taught branches of mathematics like hydrography to help establish irrigation systems, or fortifications to improve the protection of their cities.[9] 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.

Perhaps the most compelling story of the use of mathematics to gain patronage and the opportunity to teach theology is the story of the Jesuit Matteo Ricci in China. Ricci was able to gain entry into China, in part, because of gifts of mathematical objects including prisms, and clocks. These were given by Ricci and his predecessors to local leaders and even to the emperor. The Chinese were sufficiently impressed by these objects to grant the Jesuits entry. At one point, when there was trouble, and the Jesuits were at risk of being killed or expelled from China, Ricci himself believed that a world map he drew in 1584 helped secure respect for the Jesuits, allowing them to stay. Besides winning respect with such mathematical objects, Jesuit missionaries in China also gained legitimacy for their teachings. They were known for their talent for mathematics, especially astronomy. Ricci attracted the attention of wealthy Chinese

[9] Romano, 357-363.

families for his ability to teach mathematics and memorization to their sons preparing for the civil service exam. Once he had their attention, he could use his lessons as an opportunity to have more spiritual conversations with his students. If a student converted, the Jesuits were free to teach him theology in a more rigorous manner.[10] As was the case in Europe, mathematics education provided some utility to the locals and, as well, gave the Jesuits a position from which to begin teaching the faith. Once they were teaching mathematics, they could move on to the complexities of Catholic theology. Therefore, in China, mathematics became a tool for the conversion of non-Christians.

Ricci's use of mathematics as a tool to start teaching theology was not as much of a stretch as it might seem to the modern reader. Sixteenth century Jesuit mathematicians did not see a huge gap between mathematics and theology. As a matter of fact, Christopher Clavius, the leading professor of mathematics at the Collegio Romano when the Ratio Studiorum was written, believed that mathematics served as a bridge between theology and natural philosophy. This was not an uncommon argument for mathematicians of the time. The argument asserts that mathematics holds an intermediate position between theology and natural philosophy because of the nature of

[10] Peter Engelfriet, *Euclid in China: The Genesis of the First Chinese Translation of Euclid's Elements, Books I-VI (Jihe Yuanben, Beijing, 1607) and Its Reception Up to 1723* (Leiden: Brill Academic Publisher, 1998), 58-68.

the material studied. Like theology, mathematics studies abstract entities, but, like natural philosophy, it can be applied to the study of the concrete world. Often the abstract entities were necessary for the concrete applications. For example, understanding the properties of perfect circles is necessary to the construction of astrolabes, sundials, and other tools. Even the concrete matter studied by mathematics was considered divine. For example, astronomy studied the heavens, the part of creation closest to God. As the subject intermediary between natural philosophy and theology, mathematics was able to study both the divine itself and the Book of Nature, the second book of God.[11]

According to many mathematicians, including Clavius, the abstract nature of mathematics was especially important because mathematics became the only subject besides theology that had perfectly certain knowledge. Of course, the certain knowledge of theology was agreed to be a matter of faith revealed by God, while the certain knowledge of mathematics was accessible only to human reason. Euclid's *Elements* was the prime example for this argument. Euclid lived around 300 BCE, and his propositions and proofs survived, supposedly unchanged, through the end of the sixteenth century. While philosophers argued over every detail of their fields, mathematicians all agreed that the Euclidean propositions were valid and that they

[11] For an example of this argument see Clavius's preface to his 1570 commentary on the *Sphere* of Sacrobosco Christopher Clavius, *In Sphaeram Ioannis de Sacro Bosco Commentarius* (Rome: Officini Dominici Basae, 1570).

could be built on each other to create ever more complicated, but still certain, knowledge. The certainty of mathematics linked it to theology, and placed it above philosophy in the hierarchy of disciplines. Philosophical knowledge could only be as certain as the assumptions it required, but sixteenth century mathematicians maintained that the assumptions behind Euclidean geometry were so obvious that they were indisputable.[12]

While theology and mathematics may have had connections obvious to the sixteenth century mathematician, the scholastic benefits of practical mathematics were less clear. Usually abstract and practical mathematics were treated separately. Some sixteenth century mathematicians only grudgingly acknowledged the useful branches of mathematics, preferring to focus on what they saw as the noble abstract parts of the field, namely geometry, arithmetic, and especially astronomy.[13] However, under the guidance of Clavius, the Jesuits decided to embrace both the utilitarian and the noble aspects of mathematics. During his tenure as mathematics professor at the Collegio Romano, Clavius wrote three mathematics curricula of varying degrees of difficulty and fourteen textbooks on a wide variety of mathematical topics. His textbooks included a

[12] Christopher Clavius, *Euclidis Elementorum libri XV* (Rome: Vincentium Accoltum, 1574), unnumbered pages in the “Prolegomena”.

[13] In the prolog to his commentary on Euclid, Frederico Commandino makes a comment that he must address the utility of mathematics because men are only driven by profit. The tone of the comment is rather disparaging, indicating that if it were not for men’s base desire for lucre, the nobility of mathematics would be sufficient reason to study the discipline. See the “Prolegomena” in Frederico Commandino, *Euclidis Elementorum* (Pisa: 1572).

Practical Arithmetic and a *Practical Geometry* as well as commentaries on Euclid's *Elements* and Sacrobosco's *Sphere*, the medieval textbook on astronomy. While Clavius himself was primarily an astronomer, he did not neglect other branches of mathematics in his curricula. Even though all three of his curricula spent a great deal of time on astronomy and its applications, even the least rigorous included arithmetic, geography, perspective, and algebra.[14]

The first draft of the *Ratio Studiorum* called for a study of mathematics based on Clavius's curriculum for the physics students. For those not studying physics, the curriculum was less rigorous, but still required Euclid and astronomy in addition to a practical subject of the school's choosing.[15] In the review process many provinces complained that the curriculum would require devoting too much time to mathematics, a field that was difficult and not necessary for all students. Not all Jesuits were as convinced as Clavius that mathematics could bridge philosophy and theology. In fact, some Jesuit philosophers argued that mathematics was a lower faculty only useful as a

[14] Christopher Clavius, "Varia de Rebus Mathematicis Discendis et Tradens ad Annos 1581-1594," in *Monumenta Paedagogica Societatis Iesu Vol. VII*,: *Collectanea de Ratione Studiorum Societatis Iesu,* ed. Ladislaus Lukacs(Rome: Institutum Historicum Societatis Iesu, 1992), 110-115.

[15] *"Ratio Atque Institutio Studiourm,1586"* in *Monumenta Pedaegogica Societatis Iesu Vol. V: Ratio Atque Institutio Studiorum Societatis Iesu,* ed. Ladislaus Lukacs (Rome: Institutum Historicum Societatis Iesu, 1986), 110. The *Ratio Studiorum* did not indicate which of Clavius's three curricula was intended for the physics students. However, it seems most likely that the committee intended that they use either the lowest or the middle of Clavius's three curricula. The lowest of Clavius's curricula was the closest to Nadal's original mathematics curriculum. The mathematics curriculum presented in the *Ratio* was also divided into three levels, but the two lowest of those included far less mathematics than the lowest of Clavius's curricula. Furthermore, Clavius's most rigorous curriculum was designed to take three years. The physics portion of the philosophy curriculum was only one. Only the lowest of Clavius's three curricula was designed to take so short a time.

tool to train young minds in preparation for the study of the higher disciplines, including philosophy and, especially theology. Many also expressed concerns that it would not be possible to find enough qualified mathematics teachers to staff the schools. These arguments often included a suggestion that a few schools could develop strong mathematics programs that went beyond the general curriculum.[16] That suggestion was taken up in Rome where Clavius taught his most rigorous curriculum to select students in what has been called the Academy of Clavius.[17]

The mathematics curriculum was substantially whittled down from the first to the final draft of the *Ratio Studiorum.* Still, the final curriculum shows Clavius's influence and the belief that mathematics could benefit the Society both through the nobility of the study based on its connections to theology and through its utility. This paper has addressed only the first of the three rules for the mathematics teacher. That rule described what should be taught, requiring Euclid and another, unspecified subject. The second and third rules both addressed how mathematics should be taught. The third simply put in a provision for a monthly review session. Most disciplines had a similar provision. The second required that at least once every two months a mathematics student should solve an interesting problem in front of an audience of

[16] "Iudicia patrum, in proviniis deputatorum, ad examinandum Rationis studiorum (1586) tractatum, qui inscribitur "De mathematics disciplinis," in *Monumenta Pedaegogica Societatis Iesu, Vol. VI: Collectanea de Ratione Studiorum Societatis Iesu,* ed. Ladislaus Lukacs(Rome: Institum Historicum Societatis Iesu, 1992).
[17] Clavius, "Varia Rebus," p. 116 and James Lattis, *Between Copernicus and Galileo: Christoph Clavius and The Collapse of Ptolemaic Cosmology* (Chicago: University of Chicago Press, 1994), p. 24

philosophy and theology students. This, along with mathematics' placement within the philosophy curriculum, secured the discipline a place among the higher faculties, a tribute to its nobility and its connection to theology.[18] However, the open-ended nature of the first rule left room for the teaching of more utilitarian branches of mathematics. Outside of Rome, Jesuits often took advantage of this opening, using the practical applications of mathematics as a bargaining chip for the patronage that allowed them to teach the principles of Catholicism. Because the Jesuits saw teaching as a mission, both the utility and the nobility of mathematics were relevant to their efforts to spread their faith. Ultimately, the placement of mathematics within the Jesuit curriculum reflected the diverse needs of the Society's missionary goals.

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[18] Farrell, p. 46