THE JESUIT SCIENCE NETWORK

A digital prosopography on Jesuit scholars in the early modern sciences

Inauguraldissertation zur Erlangung des Doktorgrades der Philosophie in der Fakultät für Geistes- und Kulturwissenschaften der Bergischen Universität Wuppertal

vorgelegt von
Dagmar Mrozik
aus
Bad Jastrzemb/PL

1. Gutachter: Prof. Dr. Volker Remmert (BUW)
2. Gutachter: Prof. Dr. Matteo Valleriani (MPIWG)

Eingereicht am 28.09.2017
Disputation am 01.02.2018

The PhD thesis can be quoted as follows:

urn:nbn:de:hbz:468-20181211-142016-1
[http://nbn-resolving.de/urn/resolver.pl?urn=urn%3Anbn%3Ade%3Ahbz%3A468-20181211-142016-1]

Table of contents

List of Figures **7**

List of Tables **9**

1. Introduction **11**

2. Jesuit science in the early modern period **17**
2.1. Early modern sciences: Subject and terminology 18
2.2. The Society of Jesus 29
2.2.1. Characterization and history in the early modern period 29
2.2.2. Jesuit science 33
2.2.3. Story detail: From the *Constitutiones Societatis Iesu* (1558) to the *Ratio Studiorum* (1599) 41
2.3. Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus* 59
2.3.1. Terminology 59
2.3.2. The Jesuit bibliographical tradition 60
2.3.3. The *Bibliothèque de la Compagnie de Jésus* 63
2.4. Outlining the contents of Jesuit science in the early modern period . . . 66
2.4.1. Gaspar Schott's *Cursus mathematicus* 67
2.4.2. Steven Harris' modern stocktaking 70

3. The Jesuit Science Network **79**
3.1. From research interest to research task 81
3.2. Data sources 84
3.3. Information to be collected 90
3.4. Digital infrastructure: Person Data Repository 96
3.5. Data entry 101
3.6. Range and distribution 107

3.7. The project website jesuitscience.net . . . 109
3.7.1. Technical adaptations . . . 110
3.7.2. Reaching the audience . . . 111
3.7.3. Showcasing the Jesuit Science Network I: The website in screenshots . . . 117
3.8. Legal considerations . . . 138

4. Case study: Jesuit mathematicians in the Polish-Lithuanian Commonwealth 141
4.1. Select aspects of Polish-Lithuanian Jesuit history . . . 142
4.1.1. Introduction to the Polish-Lithuanian Commonwealth . . . 143
4.1.2. Jesuit beginnings and anti-Jesuit sentiments in Poland-Lithuania 149
4.1.3. Jesuit schooling in seventeenth century Poland-Lithuania: Crisis and reformation . . . 157
4.1.4. The Partitions of Poland and the suppression of the Society of Jesus . . . 161
4.2. Showcasing the Jesuit Science Network II: Data evaluations . . . 164
4.2.1. Approach and attribution . . . 165
4.2.2. Subject distribution, activity over time, and activity in mathematics . . . 165
4.2.3. Visualizing Jesuit centers of entry and activity in the Commonwealth . . . 168
4.2.4. Teacher-student relationships . . . 169

5. Follow-up work 187
5.1. Long-term operation and archiving . . . 187
5.2. Linking the JSN with the Early Modern Letters Online database . . . 189
5.3. Historical network analysis . . . 190
5.4. Exhaustion and comparability of data sources . . . 192
5.5. Prosopographical infrastructure of religious orders . . . 194
5.6. Completing the Jesuit Science Network? . . . 198

6. Final remarks 201

7. Bibliography 205

Appendices 235

A. Lists **237**
A.1. List of names based on Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus* 237
A.2. List of data sources 237
A.3. Sample for the case study 238

B. Texts from the project website **241**
B.1. Front page 241
B.2. Footer and imprint 241
B.3. About 242

Acknowledgments **245**

List of Figures

2.1. Frontispiece to Christoph Scheiner's *Rosa Ursina sive sol* (1630) 37
2.2. Exemplary page from Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus* 65
2.3. Frontispiece to Gaspar Schott's *Cursus mathematicus* 68

3.1. Two pages from the table of contents of the analytical index in volume X of the *Bibliothèque de la Compagnie de Jésus* 103
3.2. Detail from the analytical index in volume X of the *Bibliothèque de la Compagnie de Jésus* 104
3.3. Screenshot jesuitscience.net: Teaser page 114
3.4. Screenshot jesuitscience.net: Front page 119
3.5. Screenshot jesuitscience.net: Search boxes. 121
3.6. Screenshot jesuitscience.net: About 122
3.7. Screenshot jesuitscience.net: Alphabetical list of Jesuits 123
3.8. Screenshot jesuitscience.net: Alphabetical list of subjects 124
3.9. Screenshot jesuitscience.net: Alphabetical list of places 125
3.10. Screenshot jesuitscience.net: Default map view 126
3.11. Screenshot jesuitscience.net: Map view zoomed in 127
3.12. Screenshot jesuitscience.net: Quick search 128
3.13. Screenshot jesuitscience.net: Search results with filters 129
3.14. Screenshot jesuitscience.net: Data sheet for Orazio Borgondio 130
3.15. Screenshot jesuitscience.net: Source annotation 131

4.1. Frontispiece to Christoph Clavius' *Gnomonices libri octo* (1581) 152
4.2. Distinct numbers of Polish-Lithuanian Jesuits associated with a subject . 172
4.3. Polish-Lithuanian activity in mathematics 173
4.4. Places of birth versus places of entry for the Polish-Lithuanian Jesuits . . 174

4.5. Jesuit centers of activity in Education, grouped by place, overall numbers 175
4.6. Jesuit centers of activity in Career, grouped by place, overall numbers . . 177
4.7. Jesuit centers of activity in Education, grouped by subject groups, overall numbers 178
4.8. Jesuit centers of activity in Career, grouped by subject groups, overall numbers 180
4.9. Jesuit centers of activity, overall map 182
4.10. Jesuit centers of activity in the Polish-Lithuanian Commonwealth, subjects from the early modern sciences. 184
4.11. Teacher-student relationships 185

5.1. Places of birth vs places of entry for select members of the Benedictine and Jesuit orders 197

List of Tables

1.1. Digital history at the Deutsche Historikertage between 2010 and 2016 . . 12

2.1. Contents of the *Bibliothèque de la Compagnie de Jésus* volumes I through XII 64
2.2. Contents of Gaspar Schott's *Cursus mathematicus* 72
2.3. Steven Harris' categorization of topics in Jesuit publications in the early modern sciences, 1540–1800 76

3.1. First draft of the model instance for the Jesuit Science Network 91
3.2. Final version of the model instance of the Jesuit Science Network. 94
3.3. Number of names on the Bliard and Bliard* lists 108
3.4. Distribution of names across Bliard*, the DHCJ, and the studies by Lisiak and Schuppener 109
3.5. Distribution of place associations among aspects 136

A.1. Names, dates of birth and death, overlaps with Bliard* and the DHCJ, and JSN IDs for the sample based on Bogdan Lisiak's *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny* 239

Chapter 1.

Introduction

> "Although there is a computer to be found on the desk of each and any historian, a computer that is used, too, it generally seems to be restricted to text processing, Internet searches, and email communication even in the 15th year of the WWW. In fact, it is possible to hear behind closed doors that the computer is 'only something for the younger generation' and rather brings the danger of superficiality and de-scholarlification than advantages or even changes for the 'real historical scholarship'".[1]

The above quote can be found in the abstract of an accepted panel discussion on virtual borders of historical scholarship at the 48th Deutscher Historikertag in 2010.[2] Carried out by Malte Hohlbein, Patrick Sahle, and Georg Vogeler, the session was not just the only one dedicated to digital historical scholarship in that year, it was also the first one at any Historikertag for at least 15 years,[3] even despite the fact that one of the earliest conferences on the application of computational methods within the humanities

1. "Obwohl auf dem Schreibtisch jeder Historikerin / jeden Historikers ein Computer steht und auch genutzt wird, scheint sich diese Nutzung im Regelfall auch im 15. Jahr des WWW auf Textverarbeitung, Internetrecherche und E-Mail-Kommunikation zu beschränken. Hinter vorgehaltener Hand hört man sogar, der Computer sei ‚nur etwas für die jüngere Generation' und brächte eher die Gefahr der Oberflächlichkeit und Entwissenschaftlichung als Vorteile oder gar Veränderungen für die ‚echte Geschichtsforschung'." Malte Rehbein, Patrick Sahle, and Georg Vogeler, "Virtuelle Grenzen der Geschichtswissenschaft. Stand und Perspektiven der digitalen Geschichtsforschung", Deutscher Historikertag 2010, session abstract.

2. The Deutscher Historikertag or just Historikertag, organized by the Association of German Historians, is a biannual professional conference for historians and one of the largest conventions of the humanities in Europe, averaging around 3000 attendees each time. See `http://www.historikerverband.de/de/historikertag.html`, last accessed 09/26/2017. At the time of writing this, an English version of the site was not available.

3. Unfortunately, I could not digitally access programs or conference proceedings for installments of the Historikertag older than the 41st in 1996. I suspect, however, that there are no mentions of digital scholarship before that, either.

Year	Place	Sessions	Contents
2010	Berlin	1	Panel discussion on the state and perspectives of Digital History, including short presentations of showcase projects
2012	Mainz	4	Use of databases, computer-aided text analysis, social web, historical information portals
2014	Göttingen	5	Mix of discussion panels and presentations; new publication formats, social web, collaborative bibliographies, computer-aided text analysis, Wikipedia, digital source collections
2016	Hamburg	7	Including four panel discussions; showcasing current digital historical projects, basic digital skills required from researchers and students, digital archives, digital editions, historical portals

Table 1.1.: Sessions in digital history and their contents at the Deutscher Historikertag between 2010 and 2016. Information taken from the respective conference programs.

already took place in Austria, 1965.[4]

There have been three more Historikertage since 2010, and fortunately, it is possible to register a slow but steady increase in the amount of sessions in digital historical scholarship: four in 2012, five in 2014, and seven in 2016. After studying the corresponding conference programs, I have compiled Table 1.1 above showing the numbers and a summarizing content description.

Unfortunately, however, the observation that historical computer usage "generally seems to be restricted to text processing, Internet searches, and email communication" still appears to hold true. The accepted sessions predominantly cover the basics; practices in digital publication, digital sources and editions, and historical portals are all treated as services rendered for the historian, while genuinely novel projects in non-traditional forms of historical scholarship appear mostly during showcasing sessions where they are assigned only little time for their presentation.

But there is, indeed, more to digital historical scholarship than searching for literature in a library OPAC, making use of digitalizations of early modern printed works, or having students submit homework via E-learning platforms such as Moodle. In their 2015 "Guidelines for the Professional Evaluation of Digital Scholarship by Historians",

4. Dell H. Hymes, ed., *The Use of Computers in Anthropology* (The Hague: Mouton, 1965); reference after Peter Haber, "Zeitgeschichte und Digital Humanities, Version 1.0", 2012, pp. 1–2, published 09/24/2012, accessed 09/26/2017.

the American Historical Association (AHA) formulates the challenge as follows:

> "The context of historical scholarship is changing rapidly and profoundly. Disciplines and universities that emerged two centuries ago in a profusion of print now find themselves confronted with new digital forms. The historical discipline needs to address, directly and frankly, its particular disciplinary position at this historical juncture."[5]

The AHA hence recognizes that the advent of digital scholarship postulates an entirely new situation for the study of not alone history, and that no other development since the invention of the printing press were of any similar impact. The first challenge in this context is certainly finding a definition for digital history in the first place; in the same paper, the AHA proposes

> "'a broad working definition of digital history' as 'scholarship that is either produced using computational tools and methods or presented using digital technologies.' [...] Digital history in various forms often represents a commitment to expanding what history is, and can do, as a field, as well as the audiences that it addresses."[6]

This expansion in particular requires new methods of both creation and evaluation. While many a written prosopographical study, for instance, used to spend a quiet lifetime on a library shelf only to be produced by academics looking for specific information, its digital incarnation in the form of a database and a corresponding website can be found and used by anyone with access to the Internet.

With the present work on the Jesuit Science Network (JSN), a digital prosopography on Jesuit scholars in the early modern sciences, I am bringing forward one particular example for digital historical scholarship. That comprises the detailed account in this thesis as well as the digital implementation in the form of the corresponding project website jesuitscience.net—both equally important, inseparable parts of my academic performance. But the JSN fits in more than one context, and while the concept of digital history is still comparatively young,[7] the Digital Humanities, whose origins date back to

5. Edward Ayers et al., "Guidelines for the Professional Evaluation of Digital Scholarship by Historians", American Historical Association, July 2015, p. 1.

6. Ibid.

7. The term itself can be traced back to 1999, with a further generalization by 2005. See "Call for Papers for the dhnord2017", 2017, accessed 09/26/2017. Also Haber, "Zeitgeschichte und Digital Humanities, Version 1.0"; Peter Haber, *Digital Past : Geschichtswissenschaft im digitalen Zeitalter* (München: Oldenbourg Verlag, 2011).

the 1960s and even beyond,[8] could be regarded as a home for my work, as well.

In contrast to the rather well-defined understanding of digital history as formulated by the AHA, Digital Humanities possesses multiple definitions and descriptions; the literature produced in response to the question "What is Digital Humanities?" even almost constitutes its own genre now.[9] In a 2015 paper, Patrick Sahle points out the differing, yet equal natures of Digital Humanities as an academic discipline, an interdisciplinary field of research, and an auxiliary science, all depending on the observer's point of view.[10] In *Digital_Humanities* from 2012, written by Ann Burdick et al., DH is described as "less a unified field than an array of convergent practices".[11]

This diversity is not without problems. Mareike König explains it with internal tensions within the DH, citing methodological differences between computer science and the humanities, between particular disciplines in the humanities themselves, between more theoretically and more practically minded scholars, and also between those preferring a more traditionalist way of working and those embracing new technologies.[12] Since these properties are much more dividing than uniting, König instead identifies three essential characteristics of all descriptions and definitions of Digital Humanities and proposes to focus on those instead: interdisciplinarity; the research, development, and application of digital methods to questions from the humanities; and continuous self-reflection concerning research, communication, and publication processes.[13]

The third and final context of the Jesuit Science Network is the history of science, from where the underlying historical interest driving my research originates. In more concrete terms, it is the interest in members of the Society of Jesus and their scholarly activities in the early modern sciences that gave rise to the idea of creating such a digital prosopography. The Jesuits, after all, are inextricably linked with education since their very inception as a Catholic order in 1540, and as such are well known to have pursued

8. Manfred Thaller, "Geschichte der Digital Humanities", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), p. 4.

9. The best example for the multifacetedness of DH is a website called "What Is Digital Humanities?". Each time the site is reloaded, a new answer is revealed; see `http://whatisdigitalhumanities.com/`, last accessed 24/09/2017. The 817 answers in the database were contributed by participants of the open community publication project "Day of DH" between 2009 and 2014.

10. Patrick Sahle, "Digital Humanities? Gibt's doch gar nicht!", in *Grenzen und Möglichkeiten der Digital Humanities*, ed. Constanze Baum and Thomas Stäcker, Sonderband der Zeitschrift für digitale Geisteswissenschaften, 1 (2015).

11. Anne Burdick et al., *Digital_Humanities* (Cambridge: The MIT Press, 2012), p. 122.

12. Mareike König, "Was sind Digital Humanities? Definitionsfragen und Praxisbeispiele aus der Geschichtswissenschaft", Digital Humanities am DHIP, 2016, Differences among scholars, for example, are certainly not exclusive to the Digital Humanitites, but they carry much more weight in this context as interdisciplinary work offers less potential for identification. Published 17/02/2016, updated 19/02/2016, accessed 09/26/2017.

13. Again, these aspects are not exclusive to DH.

the early modern sciences in studying, teaching, and writing. What is more, there is a plethora of literature covering this pursuit and its Jesuit particularities—and yet, so far nobody has set out to create a comprehensive overview of the involved actors.

This is certainly not for a lack of biographical material. The more than a century old, twelve-volume bio-bibliographical standard reference *Bibliothèque de la Compagnie de Jésus*[14] provides an extensive source of biographical information. It is further supplemented by the modern four-volume *Diccionario Histórico de la Compañía de Jesús*[15] and other regionally focused literature.[16] As for the amount of Jesuit scholars that can be extracted, Steven Harris, who investigated the aforementioned *Bibliothèque* with particular respect to this very group, estimates that there were about 1600 of them—a number that cannot be handled properly without the help of tools and a suitable digital infrastructure, both of which the Jesuit Science Network offers.

To lay the foundation for my subsequent work, Chapter 2 focuses on the necessary historical background and understanding. I am then giving a detailed account of the actual technical implementation of the digital prosopography in Chapter 3, starting with an explanation of how the basic historical research interest in the *who*, *what*, *where*, and *when* of Jesuit activity in the sciences can be transformed and translated into a practical research task. While the perspective of this chapter shifts distinctly towards computer science and I cover more technical topics such as databases, the structure of information, or search engine optimization, the discussion still reflects and connects to the underlying historical concepts and literature. After all, it holds that the

> "set-up of a database [is] always the result of decisions [...]: Not only do you have to make a selection from the facts that are to be extracted from the sources, you also have to give them a specific structure. Information that does not conform to this structure cannot be handled. The results of these decision processes always reflect the historian's subject-specific view and the interests of the project".[17]

14. Carlos Sommervogel et al., eds., *Bibliothèque de la Compagnie de Jésus*, XII vols. (Louvain: Éditions de la Bibliothèque S.J. : Collège Philosophique et Théologique, Reprint 1960 [1890–1932]).

15. Charles O'Neill et al., eds., *Diccionario Histórico de la Compañía de Jesús*, IV vols. (Madrid: Universidad Pontifica Comillas, 2001).

16. Such as: Georg Schuppener and Karel Mačak, *Prager Jesuiten-Mathematik von 1600–1740* (Leipzig: Leipziger Universitätsverlag, 2002), Georg Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)* (Leipzig: Leipziger Universitätsverlag, 1999), Maria Reindl, *Lehre und Forschung in Mathematik und Naturwissenschaften, insbesondere Astronomie, an der Universität Würzburg von der Gründung bis zum Beginn des 20. Jahrhunderts* (Neustadt an der Aisch: Verlag Degener & Co., 1966).

17. "Aufbau einer Datenbank [ist] immer das Resultat von Entscheidungen [...]: Nicht nur wird eine Auswahl aus den Quellen zu exzerpierender Fakten getroffen, auch wird diesen eine spezifische Struktur

Following the maxim that "all Jesuit history is local history",[18] in Chapter 4 I turn to a case study on Jesuit scholars in the Polish-Lithuanian Commonwealth in Chapter 4. This study has both topical and technical relevance for the Jesuit Science Network. Not only does it give insight on local particularities of Jesuit history and its interdependencies with Polish-Lithuanian culture, shedding light on some of the aspects from Chapter 2 that are not treated in detail there, but what is more, the underlying work by Bogdan Lisiak who investigated *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*[19] (Polish Jesuits and the exact sciences from the sixteenth to the nineteenth centuries: a bio-bibliographical dictionary)[20] supplies particularly exhaustive and consistent information. Including this information in the Jesuit Science Network finally allows for statistical evaluations that help to gain a better understanding of the historical context.

The last Chapter 5 reveals another peculiarity of digital historical scholarship: the possibility of follow-up work. Historical research without a novel digital component mostly comes to an end with the publication of a written document, notwithstanding possible errata or the further advancement of particular aspects into independent new projects. Digital scholarship on the other hand by its very nature allows and tempts to continue development of the digital component and create a second, third, fourth version. As is often the case with software projects in general, it becomes clear only in the course of the actual realization what does work, what does not, what kinds of solutions or functionalities might be preferable, and what necessarily has to be retrofitted. Here, the main problem arises with a lack of funding, as financing bodies usually do not continue to facilitate further support once the project is 'completed', even if it does not make much sense to speak of a completion. Chapter 5, nonetheless, presents a whole list of ideas to enhance, expand, and interconnect the Jesuit Science Network. This emphasizes the JSN's potential, but also helps advance a change in the assessment of digital scholarship by addressing this issue head-on. Finally, in Section 5.6, I take on a discussion of what 'completion' means within the context of digital scholarship.

gegeben. Informationen, die dieser Struktur nicht entsprechen, können nicht verarbeitet werden. Die Ergebnisse dieser Entscheidungsprozesse reflektieren dabei stets die fachliche Sicht des Historikers und das Interesse des Projektes", Holger Gast, "Zum Umgang mit Datenbanken in den Geschichtswissenschaften", in *Jahrbuch für Universitätsgeschichte*, ed. Oliver Auge and Swantje Piotrowski (Stuttgart: Franz Steiner Verlag, 2013), p. 239.

18. Paul F. Grendler, "Jesuit Schools in Europe. A Historiographical Essay", *Journal of Jesuit Studies* 1 (2014): p. 8.

19. Bogdan Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny* (Kraków: Wyższa Szkoła Filozoficzno-Pedagogiczna Ignatianum, 2000).

20. Ibid.

Chapter 2.

Jesuit science in the early modern period

The Jesuit Science Network is set against the historical background of the early modern period, roughly ranging from 1450 to 1800.[1] Outside of using particular events as epochal delimiters, in this case possibly the fall of Constantinople in 1453 or the French Revolution of 1789, the early modern period can rather be characterized by a handful of major themes that describe common developmental patterns and can be traced over several centuries: a renewed growth in population and economy, the emergence of the modern state, the Protestant Reformations and the end of unified Christianity, new developments in technology and patterns of thought, European expansion and a new world view following voyages of exploration, and societal changes due to a focus shift from the community towards the individual.[2] Among these themes and the actors involved, my work concerns the early modern sciences and the Society of Jesus, both of which I will introduce over the course of this chapter. I will also discuss the concept of Jesuit science, a prominent part of the title of my work, study the beginnings of the Jesuit involvement with education in general and the early modern precursor to modern

1. A discussion in German of how to define the early modern period can be found in Ilja Micek, "Die Frühe Neuzeit. Definition, Methodendiskussion, Forschungstendenzen", in *Die Frühe Neuzeit in der Geschichtswissenschaft*, ed. Nada Boškovska (Paderborn: Ferdinand Schöningh, 1997), pp. 17–38, while Hamish Scott, "Introduction: 'Early Modern Europe' and the Idea of Early Modernity", in *The Oxford Handbook of Early Modern European History, 1350–1750*, ed. Hamish Scott, vol. 1 (Oxford: Oxford University Press, 2015), pp. 1–33 is offering a brief discourse on the English terminology. See also Andrew Pettegree, *Europe in the Sixteenth Century* (Oxford: Blackwell, 2002).

2. Luise Schorn-Schütte, *Geschichte Europas in der Frühen Neuzeit : Studienhandbuch 1500–1789*, 2., aktualisierte Auflage (Paderborn: Ferdinand Schöningh, 2013), pp. 18–19; Scott, "Introduction: 'Early Modern Europe' and the Idea of Early Modernity", pp. 2–3; Katherine Park and Lorraine Daston, "Introduction: The Age of the New", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 1 and 7.

mathematics in particular, and finally provide a classification of the contents of Jesuit science. As such, this chapter provides the historical and conceptual background for the further implementation of the Jesuit Science Network.

2.1. Early modern sciences: Subject and terminology

The purpose of this section is twofold: locate and define the so called early modern sciences, and determine the language in which to talk about them. The problem lies in the fact that some of the key terminology to describe the past has a different meaning when used in the present, as most of today's conceptions about science, the humanities, and higher education in general cannot or even must not be applied within a different context.

However, since the Jesuit Science Network is a study in Digital History, the terminology is not only determined by the historical context, but also influenced by project methodology. Working digitally often requires the use of distinct and easily identifiable descriptors, for instance as column headings in a table filled with biographical data. While these descriptors are supposed to reflect the historical contents as much as possible, there is often not much, if any space for explanations or additional comments. On one hand, choosing descriptors hence might necessitate a compromise between accuracy and ease of use, but on the other, it is exactly this challenge of finding appropriate terms that works to the advantage of digital projects: a qualitative study might be more flexible, but it introduces disarray by allowing paraphrases, exceptions, and omissions.

To make a long story short and summarize the sentiments of several introductions into early modern science,[3] 'early modern science' itself is the modern attempt to find an umbrella term for those various areas of learned activity in the early modern period that can be considered precursors to what is now often condensed to STEM, science, technology, engineering, and mathematics. Singular and plural—'early modern science' and 'early modern sciences'—can be used interchangeably without any impact on the meaning; at most, the plural term better mirrors the plurality and diversity of the encompassed contents.

3. Take, for example, Friedrich Steinle, "Naturwissenschaft", in *Enzyklopädie der Neuzeit Online*, ed. Friedrich Jaeger (Brill Online, 2016), first appeared online in 2014; Lawrence Principe, *The Scientific Revolution: A Very Short Introduction* (Oxford: Oxford University Press, 2011); Daniel Garber, "Philosophia, Historia, Mathematica: Shifting Sands in the Disciplinary Geography of the Seventeenth Century", in *Scientia in Early Modern Philosophy*, ed. Tom Sorell, G.A. Rogers, and Jill Kraye (Dordrecht Heidelberg London New York: Springer, 2010), pp. 1–17; Park and Daston, "Introduction: The Age of the New"; J. L. Heilbron, "History of science", in *The Oxford Companion to the History of Modern Science*, ed. J. L. Heilbron et al. (Oxford: Oxford University Press, 2003), pp. 370–374.

Concerning the term 'science' itself, Daniel Garber boils down in his account on the changing shape of knowledge about the natural world in the seventeenth century that "there was no such thing as science in 1600",[4] alluding to the anachronistic properties of 'science'—and the entirety of its modern semantic field—when used in a context other than the present age.[5] He brings to mind that the Latin root *scientia*, as used at the onset of the early modern period, has nothing to do with the "intellectual category"[6] of the modern English 'science'. Both do signify knowledge of something, but differ in the quality of this knowledge. As such, the philosophical positivist tradition of thought sees modern science as based on the method of observing events and/or experiments, gathering information from these observations, and eventually formulating explanatory theories based on the collected information.

Similarly, in their introduction to the third volume of the Cambridge History of Science, Katherine Park and Lorraine Daston speak of the

> "portmanteau term 'science,' taken in its sense (since the nineteenth century) of disciplined inquiry into the phenomena and order of the natural world. This modern category had no single, coherent counterpart in the sixteenth and seventeenth centuries. [...Instead, there was the] gradual emergence of a new domain of inquiry, which had some—but by no means all—of the features of natural science since about 1850. This domain embraced both intellectual and technical approaches and was composed of what had previously been disparate disciplines and pursuits, practiced by people in different professions in different institutions at different sites. [...] The medieval Latin *scientia*, although cognate with the modern English 'science,' referred to any rigorous and certain body of knowledge that could be organized (in precept though not always in practice) in the form of syllogistic demonstrations from self-evident premises."[7]

This conception of knowledge, demonstrations, and *scientia* was based on a text by Aristotle (384BC–322BC) called the Posterior Analytics.[8] Put simply, having knowledge

4. Garber, "Philosophia, Historia, Mathematica: Shifting Sands in the Disciplinary Geography of the Seventeenth Century", p. 2.

5. The meaning of the term 'science' and its equivalents in other languages has always been (and remains to be) up to debate. With respect to the German term 'Naturwissenschaft', which originated only in the nineteenth century, Steinle, "Naturwissenschaft", points out that it is applicable to earlier periods only to a limited extent.

6. Garber, "Philosophia, Historia, Mathematica: Shifting Sands in the Disciplinary Geography of the Seventeenth Century", p. 2.

7. Park and Daston, "Introduction: The Age of the New", pp. 2–3.

8. Aristotle, *Posterior analytics*, ed. Jonathan Barnes (Clarendon Press), translated with a commentary by

of something in the Aristotelian sense means having knowledge of its causes:[9] that out of which something consists (*causa materialis*); that which gives something its properties (*causa formalis*); the primary source of the change afflicted to something (*causa efficiens*); and the end for which something is done (*causa finalis*).[10] The following classical example helps to make sense of this. Imagining the something in question to be a house, the *causa materialis* are the materials from which it is constructed; the *causa formalis* are its blueprints; the *causa efficiens* is the architect building it; and the *causa finalis* is that it will protect its inhabitants from bad weather. It is not necessary for something to possess all of the causes, but at least one of them has to be known such that the knowledge of it is proper. The point to knowing the causes of something is "being able to position it within a network with other things, particularly the things that bring it into being and that make use of it",[11] which is essential to the early modern understanding that everything is interconnected with everything else.[12]

But how to gain such proper knowledge? It can either be self-evident, such as definitions, axioms, and postulates that need no further explanation or proof,[13] or it has to be inferred from already established proper knowledge. In that case, Aristotle stipulated that the inference has to be a syllogism in order to be formally correct. Syllogisms are a type of logical argument where a conclusion is derived from two or more presumably true propositions; for example, starting with the two true premises that all humans are mortal and Socrates is a human, one can deduce in a syllogism that Socrates is mortal, as well.

Finally, Charles Lohr now defines *scientia* "in the Aristotelian sense as the knowledge of syllogistically demonstrated conclusions—or, more precisely, [...] the intellectual habit by which the mind is disposed to assent to conclusions which are true and certain because derived by syllogistical demonstrations from principles and causes within a

Jonathan Barnes. For an introduction into the philosophy of Aristotelian *scientia* and its adaptation in the early modern period, see, for example, Daniel Garber, "Physics and Foundations", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 21–69.

9. Aristotle, *Posterior analytics*, 71b10–13, p. 2.

10. Andrea Falcon, "Aristotle on Causality", in *The Stanford Encyclopedia of Philosophy*, Spring 2015, ed. Edward N. Zalta (Stanford: Stanford University, 2015); Oswald Schwemmer, "causa", in *Enzyklopädie Philosophie und Wissenschaftstheorie*, ed. Jürgen Mittelstraß, vol. 2 (Stuttgart: Verlag J. B. Metzler, 2005), p. 32.

11. Principe, *The Scientific Revolution: A Very Short Introduction*, p. 24.

12. Principe, *The Scientific Revolution: A Very Short Introduction*, pp. 21–24; Garber, "Physics and Foundations", pp. 21–22.

13. Charles Lohr, "Aristotelian Theories of Science in the Renaissance", in *Sciences et religions de Copernic à Galilée*, ed. Catherine Brice and Antonella Romano (Rome: École Française de Rome, 1999), p. 17. However, this only prompts the question how to determine what is self-evident and what is not.

given domain of real entities".[14] By that understanding, theology was held as the highest and most certain of *scientiae* at the onset of the early modern period. In contrast, early modern mathematical disciplines—which would now be considered as the most certain—did not enjoy the status of a *scientia* for several reasons, the most apparent of which was that mathematical proofs do not have a syllogistic form.[15]

Before I continue with the changes of *scientia* during the early modern period, I want to briefly expand on the term 'discipline'. Again, one must be careful not to equate the modern understanding of discipline with that of the early modern period. In a 21st century understanding, a discipline is a specific, autonomous branch of knowledge and learning that features among others institutionalization in universities, a research community, salaried research and teaching positions, conferences, education schemes, and a distinct self-conception.[16] Put more abstract in sociological terms, a discipline is a "segment of formal knowledge".[17] In its early modern sense, however, discipline carried a much more general and simple meaning, describing organized education in terms of the organization of knowledge itself as well as the organization of its imparting. As such, discipline was also often used interchangeably with 'art' or 'area of knowledge'.[18]

The preceding deliberations on the nature and mode of Aristotelian-based *scientia* can be concluded as follows:

> "*Scientia* was a systematic and encyclopedic form of presentation of knowledge in which known facts were grasped in terms of their underlying principles and causes. Finding out information about the world was a first step, but in itself it did not constitute a form of understanding: knowledge that something was the case was merely a prelude to knowledge why it was the case."[19]

This conception of knowledge and how to arrive at it fundamentally changed during the early modern period, a process that is often referred to as the Scientific Revolution.

14. Ibid., p. 17.

15. For example, see the discussion in Peter Dear, "The Meanings of Experience", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 119–121. I will return to the early modern dispute over the qualities of mathematical disciplines as a *scientia* in Section 2.2.3, then from a Jesuit point of view.

16. Sahle, "Digital Humanities? Gibt's doch gar nicht!", chapter 1.

17. Eliot Freidson, *Professional Powers : A Study of the Institutionalization of Formal Knowledge* (Chicago and London: The University of Chicago Press, 1986), p. 6.

18. Martin Gierl, "Disziplinen, gelehrte", in *Enzyklopädie der Neuzeit*, ed. Friedrich Jaeger, vol. 2 (Stuttgart: Wissenschaftliche Buchgesellschaft, 2005), pp. 1064–1069.

19. Stephen Gaukroger, "The Unity of Natural Philosophy and the End of *Scientia*", in *Scientia in Early Modern Philosophy*, ed. Tom Sorell, G.A.J. Rogers, and Jill Kraye (Dordrecht Heidelberg London New York: Springer, 2010), p. 20.

While not undisputed,[20] both the concept and term have been widely spread and studied since first being coined at the end of the 1930s.[21] Accordingly diverse are the ways to characterize the transformations this brought for *scientia*. With regards to the involved Aristotelian way of reasoning, Lynn S. Joy identifies three major changes: first, a change of the very purpose of *scientia*, now asking for the how instead of the why; second, a new rejection of prior established explanations for specific phenomena; and third, a change of interest away from Aristotelian causes and towards epistemological deliberations.[22] The fundamental change of the leading question can be traced back to an inadequacy of *scientia* to explain many occurrences of the natural world, as knowing something by its causes deals only with the "natural behaviour of bodies, not any other behaviour they might undergo".[23] When a stone, for instance, falls to the ground, it does so because of its inherent natural weight; but when it is raised upwards, say by a pulley or in the hand of a person, this is not the result of any natural property of the stone. Along with the leading question, its solution process changed as well, with a growing emphasis on observation, experimentation, and mathematical models.[24]

According to historian of science, philosopher, and sociologist Edgar Zilsel, this change in methodology came about with a change in social custom.[25] He outlines three groups of actors who pursued intellectual activity between 1300 and 1600, university-scholars, humanists, and artisans. The first, university-trained group was characterized by their reliance on the classic authorities, engaging in their subjects mostly by commenting and annotating in Latin. They were interested in the (Aristotelian) causes, but not the

20. "There was no such thing as the Scientific Revolution", for instance, reads the provocative and by now quite famous first sentence in Steven Shapin, *The Scientific Revolution* (The University of Chicago Press, 1996), p. 1.

21. To name but a few references: Floris Cohen, *Die zweite Erschaffung der Welt. Wie die moderne Naturwissenschaft entstand* (Bonn: bpb, 2011); Principe, *The Scientific Revolution: A Very Short Introduction*; Peter Dear, *Revolutionizing the Sciences : European Knowledge and Its Ambitions, 1500–1700* (Princeton: Princeton University Press, 2009); Shapin, *The Scientific Revolution*; Floris Cohen, *The Scientific Revolution : A Historiographical Inquiry* (Chicago: The University of Chicago Press, 1994); and Alexandre Koyré, *Études galiléennes* (Paris: Hermann, 1939), where the concept of the Scientific Revolution was first introduced.

22. Lynn S. Joy, "Scientific Explanation from Formal Causes to Laws of Nature", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 70–73. For a different set of 'revolutionary transformations', see Cohen, *Die zweite Erschaffung der Welt. Wie die moderne Naturwissenschaft entstand*, Chapter 3.

23. Gaukroger, "The Unity of Natural Philosophy and the End of *Scientia*", p. 25.

24. Garber, "Physics and Foundations", pp. 36–43; Ann Blair, "Natural Philosophy", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 372–390, 399–403; Dear, "The Meanings of Experience", especially pp. 124–130; Peter Dear, *Discipline & Experience* (Chicago: The University of Chicago Press, 1995).

25. Edgar Zilsel, *The Social Origins of Modern Science*, ed. Diederick Raven (Dordrecht: Springer Science+Business Media, 2003), pp. 3–6, 7–21.

physical laws of the natural world.[26] The second group comprised equally university-trained officials and clerks who, responsible for the foreign affairs of their employers, aimed to achieve fame and esteem by composing articulate writings and speeches, and looked back to classical authors for style and knowledge. They, too, wrote and spoke only Latin.[27] The members of the third group are called artisans, craftsmen, or artist-engineers by Zilsel,[28] meaning men who worked as painters, shipbuilders, sculptors, architects, miners, gunners, carpenters, foundry workers, or mariners, for instance. They had no higher education, communicated in the vernacular, and sometimes were even illiterate.[29] University-scholars and humanists alike looked down upon them because of their manual labor, and hence dismissed their methods of learning by empirical observation and experimentation. This dismissal also concerned the mathematical knowledge vital to many of the artist-engineers.

Zilsel now identifies the "methodical training of the intellect" of the university-scholars and humanists on one hand and the "experimental method"[30] of the artist-engineers on the other as the two components that make up modern science. He attributes their incorporation to early modern scholars such as William Gilbert (1544–1603), Galileo Galilei (1564–1642),[31] and Francis Bacon (1561–1626), and sums up the development as follows:

> "About 1550, however, with the advance of technology, a few learned authors began to be interested in the mechanical arts, which had become economically so important, and composed Latin and vernacular works on the geographical discoveries, navigation and cartography, mining and metallurgy, surveying, mechanics, and gunnery. Eventually the social barrier between the two components of he [sic] scientific method broke down, and the methods of the superior craftsmen were adopted by academically trained scholars: real science was born."[32]

In their respective studies on mechanical arts and natural philosophy in the Cambridge History of Science, Jim Bennett and Ann Blair trace the methodological changes of *scientia*

26. Ibid., pp. 10–11.
27. Ibid., pp. 4, 11.
28. Ibid., pp. 4, 11, 14.
29. Ibid., p. 13.
30. Ibid., p. 5.
31. On the notion of Galileo's status as engineer, see especially Matteo Valleriani, *Galileo Engineer* (Dordrecht: Springer, 2010); a general in-depth biography can be found in John Heilbron, *Galileo* (Oxford: Oxford University Press, 2010).
32. Zilsel, *The Social Origins of Modern Science*, p. 15.

in the early modern period along similar lines (albeit without reference to Zilsel). The mechanical arts, central matter of the quote above and defined by Bennett as "the skillful practice of a particular discipline or handicraft, including the working of machines", were one of the first areas of learning to take on a mathematical-speculative aspect.[33] But although the involved mathematics thus dealt with material things, they were considered of no relevance to natural philosophy, "the central discipline dedicated to laying out the principles and causes of natural phenomena",[34] since they did not deal with the causes of these material things. Bennett concludes:

> "Eventually, however, practical mathematicians built such an extensive network of mathematical practice that their engagement with natural philosophy became inevitable. Through this engagement, the techniques of practical mathematics—mechanical manipulation, mathematical generalization, and the use of instruments—came to be applied to the study of the natural world."[35]

My presentation is, of course, a highly simplified account, with which I can merely hint at some of the currents of the Scientific Revolution. The transformations of *scientia* did not happen overnight, not all developments were permanent, and neither was Aristotelianism abandoned straightaway.[36] The early modern areas of knowledge and their philosophical foundations remained an ever-changing landscape, in fact, a landscape without a definite roadmap. Whatever representations can be found in contemporary sources are snapshots that reflect a particular historical moment along with the educational, social, philosophical, and religious contexts of their author.[37]

In order to still arrive at a general overview, it is hence sensible to rely on a modern perspective and take an overarching look back. The structure mirrored in the table of contents of the third volume of the Cambridge History of Science seems to me to be

33. Jim Bennett, "The Mechanical Arts", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), p. 674, quote on p. 673.

34. Blair, "Natural Philosophy", p. 365.

35. Bennett, "The Mechanical Arts", pp. 675–676.

36. See, for instance, the collection of articles in Paul Richard Blum, *Studies on Early Modern Aristotelianism* (Brill, 2012), many with a Jesuit focus, along with Christia Mercer, "The Vitality and Importance of Early Modern Aristotelianism", in *The Rise of Modern Philosophy : The Tension between the New and Traditional Philosophies from Machiavelli to Leibniz*, ed. Tom Sorell (Oxford: Clarendon Press, 1993), pp. 33–67.

37. See, for example, the classifications provided by two prominent early modern encyclopedic works, namely the *Encyclopaedia septem tomis distincta*, published by Johann Heinrich Alsted (1588–1638) in 1630, and the *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc.* edited by Denis Diderot (1713–1784) along with Jean-Baptiste le Rond d'Alembert (1717–1783) and published between 1751 and 1780. The first volume of the *Encyclopédie* contains the *Système Figuré des Connaissances Humaines*, a graphical representation of the divisions of knowledge.

a good starting point for that.[38] Part III, aptly named "Dividing the study of nature", comprises natural philosophy, medicine, natural history, cosmography, alchemy and chemistry/chymistry,[39] magic, astrology, astronomy, acoustics and optics, mechanics (theoretical aspects) and the mechanical arts (practical aspects), and pure mathematics. For the time being, this listing shall suffice, and I also want to defer the task of specifying the actual contents of these particular topics to the respective chapters in the Cambridge History. In Section 2.2.2, I will return to this classification and pick up the discussion from a Jesuit perspective.

It is a commonly held point of view nowadays that science and religion are and always have been mutually exclusive. But this perceived incompatibility only manifested itself and became a trope in historiography in the late nineteenth century; "before secularism became the norm in the West God and religion were so pervasive in social, political and intellectual life that it seems fair to say that all but a very few intuitively thought in a religious way".[40] Especially in the early modern period, being a Christian was the norm, and the "doctrines of Christianity were not opinions or personal choices. They had the status of natural or historical facts."[41] This, of course, had repercussions on learned activities. As the earliest explanations of life came from religion, then philosophy, then *scientia*, religion influenced philosophy and philosophy influenced *scientia*; hence, theological tenets were considered part of the data set with which early modern natural philosophers worked.[42] At the same time, there is no denying that both the Catholic and the Protestant Churches took up some "kind of policing of innovatory natural philosophy"[43] in order to preserve unity and authority. This happened most notably by way of censorship and the requirement for higher approval, everyday practices in publication processes.

The last aspect of the early modern sciences that I would like to address now concerns its practitioners. For that purpose I am mainly following Steven Shapin, who wrote repeatedly about this topic. Calling these men[44] scientists would probably be the grossest

38. Katherine Park and Lorraine Daston, eds., *Cambridge History of Science*, vol. 3 (Cambridge: Cambridge University Press, 2006).

39. To be precise, this chapter is called "From Alchemy to 'Chymistry'".

40. John Henry, "Religion and the Scientific Revolution", in *The Cambridge Companion to Science and Religion*, ed. Peter Harrison (Cambridge: Cambridge University Press, 2010), p. 39.

41. Principe, *The Scientific Revolution: A Very Short Introduction*, p. 36.

42. Ibid.

43. Henry, "Religion and the Scientific Revolution", p. 41.

44. Shapin notes that the "man of science was [...] almost always male, and to use anything but this gendered language to designate the pertinent early modern role or roles would be historically jarring." Steven Shapin, "The Man of Science", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), p. 179. On the role of women in the early

anachronism and historical inaccuracy so far, and not only for the reason that the term did not even exist before the nineteenth century.[45] The modern scientist, perceived as an independent, professional researcher with an academic background earning their livelihood by way of their research,[46] differs vastly from the early modern 'scholar':

> "In sixteenth and seventeenth century usage, the term 'scholar' might refer to individuals fulfilling several loosely related but different roles. Most generally, the 'scholar' could be anyone who received his instruction from an acknowledged 'master'. Any child or young person undergoing a course of education (privately or publicly) might be counted a 'scholar'. The term could (as an evaluative discrimination) designate someone in the process of being educated who was notably able, or (in the administrative sense mentioned above) who received emoluments from the institution by virtue of his abilities. It might more specifically refer to someone whose learning was considered to be especially extensive or deep, whatever his means of support; and, finally, it might indicate someone professionally engaged in the pursuit or transmission of knowledge, particularly in institutions of higher education."[47]

A scholar who pursued the early modern sciences furthermore did so "within a range of traditionally established social roles".[48] Here Shapin's account calls to mind the same three groups that Edgar Zilsel defined:[49] university scholars, officials such as clergyman, tutors, or clerks, and "those being bred to artisanal or mercantile work",

modern sciences, see the following introductory works: Alisha Rankin, "Women in Science and Medicine, 1400–1800", in *The Ashgate Companion to Women and Gender in Early Modern Europe*, ed. Allyson Poska, Katherine McIver, and Jane Couchman (Ashgate Press, 2013); Londa Schiebinger, "Women of Natural Knowledge", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), pp. 192–205; and the collective volume by Judith P. Zinsser, ed., *Men, Women, and the Birthing of Modern Science* (DeKalb: Northern Illinois University Press, 2005).

45. 'Scientist' was proposed by the English mathematician and poet William Whewell (1794–1866) in the 1830s, and its use actually remained disputed for quite some time. Steven Shapin, *The Scientific Life : A Moral History Of A Late Modern Vocation* (Chicago: The University of Chicago Press, 2008), p. 322, footnote 7 to p. 24.

46. This description is my very condensed and simplified summary of and conclusion to the first two chapters in Freidson, *Professional Powers : A Study of the Institutionalization of Formal Knowledge*. They address knowledge, its agents, and most of all the character of and difficulty in defining the semantic field around 'profession'.

47. Steven Shapin, "'A Scholar and a Gentleman': The Problematic Identity of the Scientific Practitioner in Early Modern England", *History of Science* 29, no. 3 (1991): p. 287.

48. Shapin, "The Man of Science", p. 180.

49. See the discussion on page 22.

the artisan-engineers.[50] With regards to the group of officials, Shapin points out that "university education was part of a background preparation for roles in civic life, and the acquisition of scientific expertise, or at least of that expertise for which they became known, occurred elsewhere".[51] He finally adds that even university positions in the sciences were mostly regarded as stepping stones towards other, better paid, and overall more secure positions, for instance at noble courts.[52]

In all this, particular importance is attached to the above cited social roles. While the modern scientist seeks out a career in science according to their own interests, abilities, and free will (at least ideally), life in the early modern period proceeded along much more restricted and predetermined lines. Christian society of the late Middle Ages commonly knew three social classes with distinct tasks, namely those who prayed, those who fought and protected, and those who labored.[53] While the division into classes became more finegrained over time,[54] the understanding that each class member was obligated to stay within the boundaries of their class and fulfill its associated duties remained. The ultimate objective of human life hence consisted not in individual fulfillment in the mortal world, but in religious salvation and redemption in the afterlife. The social position one was born into, as intended by God, predetermined the course:

> "The opportunities on offer to the poorest sections of the population – labourers, cottagers, and their families – were highly restricted. They had to seek subsistence where they could find it. A formidable combination of guild ordinances, apprenticeship laws, and poor law regulations severely limited the ability of individuals to take up whatever form of employment they fancied; and their inherent aptitudes and interests can seldom have been a determining consideration. In the middling ranks, there was more scope for personal preference, but options were normally restricted by parents' resources and their network of acquaintance. In agriculture, mining, and handicrafts there was a strong, though not invariable, presupposition in favour of occupational continuity between father and son. [...] At the upper levels of society, choice

50. Shapin, "The Man of Science", pp. 182–183, the quote is from p. 183. Shapin gives various examples of the backgrounds and activities of scholars in the early modern sciences on these two pages.

51. Ibid., p. 183.

52. Shapin, "The Man of Science", pp. 183–184; also Marita Hübner, "Professionalisierung : Wissenschaft", in *Enzyklopädie der Neuzeit*, ed. Friedrich Jaeger, vol. 10 (Stuttgart: Wissenschaftliche Buchgesellschaft, 2009), pp. 440–442.

53. Thomas Sokoll, "Beruf", in *Enzyklopädie der Neuzeit*, ed. Friedrich Jaeger, vol. 2 (Stuttgart: Wissenschaftliche Buchgesellschaft, 2005), col. 43.

54. Different scholars came up with different classifications. See Keith Thomas, *The Ends of Life : Roads to Fulfilment in Early Modern England* (Oxford: Oxford University Press, 2009), pp. 15–16.

> was also limited. The heir of a nobleman or gentleman had his role in life predetermined: whatever his personal tastes, he had to take on the management of the family estates and the public responsibilities that went with them. Younger sons had potentially more freedom, but, in the seventeenth century, they were in practice usually assigned by their fathers to the law, the Church, and the business world, often in that order and regardless of aptitude.
> When a child's future occupation was not already settled in advance by birth and circumstances, it was widely held that the decision should be made by others on his behalf. [...] All contemporary moralists agreed that parental consent was important in the choice of a career; and most of them assumed that, although the child's aptitudes should be taken into account, it was the parents who would take the lead in deciding."[55]

The concepts of 'career' and 'occupation' in the early modern period are hence fundamentally different from their modern counterparts grounded on free choice, personal development, and social mobility. The discussion so far illustrates the difficulty of trying to succinctly grasp and describe the early modern sciences along with their practitioners, but also mirrors the immense changes and developments that characterize early modernity. However, a categorization, even if it cannot be historically adequate for the entire period under consideration, is the prerequisite for the later practical digital implementation. In light of the different concepts and expressions used so far, I would thus like to propose and determine the following basic nomenclature.

Early modern science(s) As established, the interchangeably used 'early modern science' and 'early modern sciences' describe the broad landscape of learned inquiry into the natural world during the early modern period, from Aristotelian *scientia* to the developments of the Scientific Revolution. The basic classification of its contents are natural philosophy, medicine, natural history, cosmography, alchemy and chemistry/chymistry, magic, astrology, astronomy, acoustics and optics, theoretical and practical aspects of mechanics, and pure mathematics.

Subject The particular contents of early modern science are called 'subjects'.

Scholar Following the definition given earlier, a scholar is a learned man of early modernity, regardless of the subject in which he received his instructions. There is no special notion for practitioners of the early modern sciences.

55. Thomas, *The Ends of Life : Roads to Fulfilment in Early Modern England*, pp. 16–17.

2.2. The Society of Jesus

It is now time to introduce and characterize the main protagonist of this work: the Society of Jesus, Latin *Societas Iesu*, henceforth also simply referred to as the Jesuits. Over the course of the next three sections, I will portray this religious community and its relationship with the early modern sciences.

2.2.1. Characterization and history in the early modern period

Created in 1540 by Ignatius of Loyola (1491–1556) partially as a reaction to the Protestant Reformations, the Jesuits were a completely new type of religious congregation that neither chose a withdrawn, monastic life, nor decided to wear a common habit. Instead, serving God in service to others was (and still is) a key element of Jesuit spirituality, with the pursued maxim being *contemplatio in actione*, contemplation in action.[56]

In addition to the traditional Evangelical counsels of chastity, poverty, and obedience,[57] the Jesuits postulated a fourth vow on the absolute dedication to "itinerant ministry", often misunderstood as an unconditional obedience towards the pope.[58] The explicit formulation of this fourth vow was important insofar as the Society of Jesus saw its main apostolic tasks in pastoral care, education, and missionary work, and, in order to accomplish them, regularly summoned its members to other places not only within, but also outside of Europe.[59]

Among these tasks, it is probably the educational endeavor for which the Jesuits became known the most.[60] Since Ignatius of Loyola and his first confrères had themselves

56. Markus Friedrich, *Die Jesuiten* (München/Berlin: Piper, 2016), pp. 69–71; for more insight into Jesuit spirituality, see Steven Harris, "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition", *Science in Context* 3 (1989): pp. 48–49.

57. For a brief introduction into the nature of Jesuit obedience, see Friedrich, *Die Jesuiten*, pp. 94–99. It should be noted that this obedience was supposed to concur with prudent independence and self-confident autonomy (p. 97).

58. The dedication to missionary activity came with the understanding that the pope "had the broad vision required for the most effective deployment" and thus should point the right way. This was falsely interpreted as blind obedience towards the pope. John O'Malley, *The First Jesuits* (Cambridge: Harvard University Press, 1993), pp. 298–290.

59. Missionary activity was not restricted to traveling to distant places and proselytizing nonbelievers. For a Jesuit, going on a mission could also mean going to the Italian countryside to help strengthen the locals' faith in the Catholic church, and particularly attempt to reconvert those who had adopted a Protestant belief. Ibid., pp. 16,115–127.

60. For further reading on the development of Jesuit schooling, I recommend the following selection of titles: Grendler, "Jesuit Schools in Europe. A Historiographical Essay"; Alexander Karp and Gert Schubring, "Mathematics Education in Europe in the Premodern Times", chap. 7 in *Handbook on the History of Mathematics Education*, ed. Alexander Karp and Gert Schubring (New York: Springer, 2014), pp. 129–151; Matthias Asche, "Kollegien, Kompetenz und Kostenkalkül – jesuitische Erfolgsrezepte an Universitäten im Konfessionellen Zeitalter", in *Historisches Jahrbuch*, ed. Karl-Heinz Braun et al. (München: Verlag Karl

studied at the university in Paris and Loyola envisioned the Society as an intellectual elite, the main concern in the early days was to ensure that future Jesuits received an appropriate education. Because of that, novitiates were required to successfully complete their studies before they were fully admitted,[61] an expression of their "strong determination to be themselves well-educated by the prevailing standards of the day and to pursue the vigorous application of the same standards by extending them to all their charges".[62]

But the Jesuits soon found themselves also accepting lay students, and quickly realized that providing education for non-members offered an excellent way of fulfilling their service to others as well as propagating their religious teachings and ideals. Lessons free of charge, a reputation of expert knowledge, and the foundation of colleges in places where there had been no schools before are only some of the reasons behind the rapid expansion of Jesuit schooling in the sixteenth century. As a result, there were some 250 colleges worldwide until 1600,[63] although the success did not come without issues such as a shortage of teachers or problems with corporal punishment.[64]

An often mentioned 'innovation' through which the Society distinguished itself in its teaching is the adaptation of the so called *modus parisiensis* or Parisian mode. This

Alber Freiburg, 2013), pp. 57–75; Rainer Müller, "The 'Jesuitensystem' in the university structure of early modern Germany", in *Gesuiti e università in Europa (secoli XVI–XVIII)*, ed. Paolo Brizzi and Roberto Greci (Bologna: CLUEB, 2012), pp. 95–108; Philippe Rocher, *Le goût de l'excellence : Quatre siècles d'éducation jésuite en France* (Paris: Beauchesne, 2011); Krista De Jonge, "The First Jesuit Schools in the Southern Low Countries 1585–1648", in *Public buildings in early modern Europe*, ed. Koen A. Ottenheym (Turnhout: Brepols, 2010), pp. 307–324; Luce Giard, "The Jesuit College. A Center for Knowledge, Art, and Faith 1548–1773", *Studies in the Spirituality of Jesuits* 40 (2008): pp. 1–31; Ugo Baldini, "The Jesuit College in Macao as a meeting point of the European, Chinese and Japanese mathematical traditions. Some remarks on the present state of research, mainly concerning sources (16th–17th centuries)", in *The Jesuits, the Padroado and East Asian Science (1552–1773)*, ed. Luís Saraiva and Catherine Jami (Singapore: World Scientific Publishing, 2008), pp. 33–79; Olwen Hufton, "Every Tub on Its Own Bottom: Funding a Jesuit college in Early Modern Europe", in *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, ed. John O'Malley (Toronto: University of Toronto Press, 2006), pp. 5–23; Judi Loach, "Revolutionary Pedagogues? How Jesuits Used Education to Change Society", in *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, ed. John O'Malley (Toronto: University of Toronto Press, 2006), pp. 66–85; Ladislaus Lukács, "A History of the Ratio Studiorum", in *Church, culture, and curriculum: theology and mathematics in the Ratio studiorum*, ed. Frederick A. Homann (Philadelphia: Saint Joseph's University Press, 1999), pp. 17–46; Aldo Scaglione, *The liberal arts and the Jesuit college system* (Amsterdam: John Benjamins Publishing Company, 1986); John Donohue, *Jesuit Education* (New York: Fordham University Press, 1963).

61. Steven Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773" (PhD diss., University of Wisconsin-Madison, 1988), provides a concise description of the challenges of the Jesuit noviciate on pp. 45–51. The part pertaining to the necessity of completing the demanded studies can be found on p. 49.

62. Scaglione, *The liberal arts and the Jesuit college system*, p. 2.

63. Peter Walter and Melanie Wald, "Jesuiten", in *Enzyklopädie der Neuzeit*, ed. Friedrich Jaeger, vol. 6 (Stuttgart: Wissenschaftliche Buchgesellschaft, 2007), p. 9.

64. O'Malley, *The First Jesuits*, pp. 227–232.

expression refers to the organized, centralized, and authoritative type of university modeled after the contemporary Paris university; two of its features were the division of students into classes according to their abilities and level of knowledge instead of their age, as was the custom before, and the incorporation of regular practical exercises.[65] In terms of curriculum and pedagogy, Italian Renaissance humanism had a strong influence.[66] Jesuit colleges also extensively featured the use of theater, art, and music.[67] Performances were held publicly and served towards the integration of the college into the community, functioned as an educational vehicle, and also fulfilled propagandistic purposes.

Not everything that the Jesuits did garnered positive attention, however. Already suspiciously regarded because of their institutional peculiarities and their chosen name,[68] anti-Jesuit sentiments found their first expression in the condemnation of the Society by the Faculty of Theology of Paris in 1554.[69] The Society's strict order, lending of military vocabulary,[70] and habitual method of accommodating to local circumstances in regard to clothing, languages, traditions, or even religious rites further elicited criticism or outright hostility.[71]

The so called Chines Rites Controversy is a particularly prominent example in this context. Spanning the seventeenth and eighteenth centuries, it was centered around the question whether Confucianism and the Chinese traditions of honoring the dead were reconcilable with Christian belief; the Jesuits encountered heavy objection for speaking out in favor of the Chinese.[72] In general, the "adaptive spirit of the Jesuits was mistaken

65. For a more elaborate account, see Gabriel Codina, "The 'Modus Parisiensis'", in *The Jesuit Ratio Studiorum : 400th Anniversary Perspectives*, ed. Vincent J. Duminuco (New York: Fordham University Press, 2000), especially pp. 32–38.

66. Grendler, "Jesuit Schools in Europe. A Historiographical Essay", p. 11.

67. See, for example, Fidel Rädle, "Jesuit Theatre in Germany, Austria and Switzerland", in *Neo-Latin Drama in Early Modern Europe* (Leiden: Brill, 2013), pp. 185–292; Henrique Leitão and Samuel Gessner, "Euclid in tiles: the mathematical azulejos of the Jesuit college in Coimbra", *Mathematische Semesterberichte* (2014); T. Frank Kennedy, "Music and Jesuits: Historiography, and a Global Perspective", *Journal of Jesuit Studies* 3 (2016): pp. 365–376.

68. Many other religious orders such as the Franciscans or the Dominicans had been named after their founding father; that the the Jesuits named themselves after Jesus was seen as a grave appropriation and provoked a lot of resentment.

69. Kennedy, "Music and Jesuits: Historiography, and a Global Perspective", p. 367; Larissa Juliet Taylor, *Heresy and Orthodoxy in Sixteenth-Century Paris : François Le Picart and the Beginning of the Catholic Reformation* (Leiden: Brill, 1999), pp. 122–123.

70. Concerning the military imagery associated with or used by the Jesuits, see O'Malley, *The First Jesuits*, pp. 34, 45, 69, 352.

71. The willingness to adapt to the given conditions contributed greatly to the success of the Jesuit missionary endeavor, which in turn increased the hostility felt towards the order. Friedrich, *Die Jesuiten*, pp. 506–513; Steven Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773", *Isis* 96 (2005): p. 76.

72. Following the literature recommendations in Florence C. Hsia, *Sojourners in a strange land : Jesuits and*

for a kind of deliberate camouflage"[73], which only fed into the "myth of the conspiring, power-hungry Jesuit"[74] This myth had gained early broad currency with the anonymous publication of the *Monita Secreta Societatis Jesu* (Secret admonitions of the Society of Jesus) in Kraków in 1614.[75] This pamphlet, soon traced back to the resentful Polish ex-Jesuit Hieronim Zahorowski (1582–1634) who had been expelled for unbecoming behavior and failing the theology course,[76] outlines the allegedly true intentions of the Jesuits to amass wealth and political influence. Despite quickly being determined as fake and condemned in Rome, the *Monita Secreta* spread all over Europe in several editions and translations, propagating and bundling anti-Jesuit sentiments.[77] The fact that members of the Society, due to their working as private tutors and confessors at noble courts, regularly came into close contact with dignitaries only added fuel to the fire.[78]

The issues sketched so far are not intended to be exhaustive and can only be viewed as indicative of the basic themes of contemporary antagonism and outright enmity towards the Society of Jesus. The resulting tensions were further incited by a whole range of long-, medium, and short-range developments on a variety of levels—economical, social, cultural, theological, and political—that often enough did not even have any immediate connection with the Jesuits, and finally began to release in the second half of the eighteenth century with Portugal's 1759 decision to expel the order. France followed suit in 1764, Spain, Naples, and Sicily in 1767, and Parma in 1768. Eventually, under

their scientific missions in late imperial China (Chicago: The University of Chicago Press, 2009), p. 195, Note 7, see: David E. Mungello, ed., *The Chinese rites controversy : Its history and meaning* (Nettetal: Steyler Verlag, 1994); Paul A. Rule, *Kung-tzu or Confucius? : The Jesuit interpretation of Confucianism* (Sidney: Allen & Unwin, 1986); Antonio Sisto Rosso, *Apostolic legations to China of the eighteenth century* (South Pasadena: P.D. / I. Perkins, 1948).

73. Sabina Pavone, "Between History and Myth: The *Monita secreta Societatis Jesu*", in *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, ed. John W. O'Malley et al. (Toronto: University of Toronto Press, 2006), p. 58.

74. Ibid., p. 57.

75. *Privata Monita Societatis Jesu* (Notobirga, 1614). The given place of publication, *Notobirga*, is fictitious. In early editions, the *Monita* were mostly called *privata* (private, secret), only later did *secreta* become the favored designation. See the note preceeding the table of contents in Sabina Pavone, *The Wily Jesuits and the Monita secreta : The Forget Secret Instructions of the Jesuits: Myth and Reality* (Saint Louis: The Institute of Jesuit Sources, 2005).

76. On Zahorowski's person and authorship as well as the genesis of the *Monita Secreta*, see ibid., pp. 27–41, along with Janusz Tazbir, "Hieronim Zahorowski : Zapomniany autor głośnego pamfletu", *Kwartalnik historyczny* LXX, no. 2 (1963): pp. 341–361. Interestingly enough, Zahorowski withdrew his accusations shortly after the publication of his work and later in life even became a benefactor of the Lublin Jesuits, in whose church he was buried.

77. A bibliography of the editions of the *Monita* can be found in Pavone, *The Wily Jesuits and the Monita secreta : The Forget Secret Instructions of the Jesuits: Myth and Reality*, pp. 234–242. In Section 4.1.2 on page 149, I will return to the *Monita secreta* and speak of other anti-Jesuit sentiments in the context of the Polish-Lithuanian Commonwealth.

78. Friedrich, *Die Jesuiten*, illuminates the difficult reality of Jesuit presence and agency at royal courts on pp. 271–280.

pressure particularly from France, Pope Clement XIV (1705–1774, papacy 1769–1774) issued the suppression of the Society in 1773.[79] Since several states had already begun to banish Jesuits and confiscate any possessions or buildings under their care, the papal issue was more a canonical sanction of the events rather than their trigger. The factual implementation of the suppression then depended on geopolitical circumstances, and thus varied in severity; the Russian Empress Catherine the Great (1729–1796, reign 1762–1796), for example, outright prohibited the promulgation of the papal bull in her Empire.[80] Nevertheless, the Society of Jesus ceased to exist for the next 40 years and was only reinstated in 1814.

Since their beginnings in 1540, the Jesuits had continually grown and expanded into a well organized and interconnected religious organization that was acting worldwide. Around the year 1750, the order counted more than 22500 members and maintained, among other, 750 colleges with 210000 students across the globe;[81] when the papal suppression was reversed, the official member count was down to merely some 500 men. Albeit the Society of Jesus managed to rise again and reestablish itself over time, it never returned to earlier strength and influence. The forty year ban prevented any organized work, public seizure of Jesuit resources ruined the established infrastructure and took away material and financial means, and the 'old' system and self-image of the Society did not fit into the changed political landscape of the beginning nineteenth century anymore.

2.2.2. Jesuit science

As I have mentioned earlier, 'Jesuit science' does not just make up two thirds of the 'Jesuit Science Network' title, but is actually a concept with a particular meaning. Used as a fixed expression in the research literature, it is often featured in the titles or subtitles of

79. A concise and well-rounded entry point into these developments along with plenty of references for a more detailed study can be found in Friedrich, *Die Jesuiten*, pp. 526–547. The depiction of the events leading up to the expulsion of the Jesuits from Portugal and France are two especially good examples for the complexity of the situation (pp. 538–542). See also Jonathan Wright, "The Suppression and Restoration", in *The Cambridge Companion to the Jesuits*, ed. Thomas Worcester (Cambridge: Cambridge University Press, 2008), pp. 263–277.

80. This took place in the greater context of the so called Partitions of Poland between 1772 and 1795 when the prior sovereign Polish-Lithuanian Commonwealth was annexed and completely broken up between its neighbors Prussia, Russia, and Austria. The three powers each dealt with the Society in a different way, as I will discuss later in Section 4.1.4.

81. The numbers fluctuate depending on the sources. See, for example, Peter C. Hartmann, *Die Jesuiten* (München: C.H. Beck, 2008), p. 78; Walter and Wald, "Jesuiten", pp. 9–10; Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773", p. 72.

articles, collections, or monographs.[82] Expressions such as 'Jesuit mathematics' or 'Jesuit natural philosophy'—where 'science' is replaced by a specific subject—are also frequent occurrences,[83] raising the question whether they can be simply viewed as subsets of Jesuit science or constitute concepts that fundamentally differ in their meaning.

Taking a closer look at the contents of these works reveals that Jesuit science comes with a set of predetermined qualities, but that these qualities are rarely explicitly mentioned; at most, authors allude to them in some way. Alfredo Dinis' contribution in one of the collections on Jesuit science edited by Mordechai Feingold seems especially notable to me in this regard.[84] The paper, whose title does not refer to Jesuit science but the science during the lifetime of a particular Jesuit, begins with a two-page discussion under the sub-heading "Some Misconceptions about Jesuit Science". Without explicitly calling it a definition, Dinis refers to the "Jesuit tradition in theology, philosophy, and science during the early modern period" in his first sentence, and then determines the misconception that he perceives many researchers to have about said tradition as a "general misconception about the Jesuits' lack of freedom in their search for truth".[85] But what exactly is to be understood under the 'Jesuit tradition in science', and how can the involved 'search for scientific truth' be characterized?[86]

82. Some selected works using 'Jesuit science' in their titles are Sheila J. Rabin, "Early Modern Jesuit Science. A Historiographical Essay", *Journal of Jesuit Studies* 1 (2014): pp. 88–104; Miguel de Asúa, "Jesuit Science in the Missions of Paraguay and Río de la Plata", in *Latin American Perspectives on Science and Religion*, ed. Ignacio Silva (London: Routledge, 2014), pp. 71–84; Per Pippin Aspaas, *Maximilianus Hell (1720-1792) and the Eighteenth-Century Transits of Venus : A Study of Jesuit Science in Nordic and Central European Contexts* (Tromsø: Tromsø Universitetet, 2012); Mordechai Feingold, ed., *Jesuit Science and the Republic of Letters* (Cambridge: The MIT Press, 2003); Geert Vanpaemel, "Jesuit Science in the Spanish Netherlands", in *Jesuit Science and the Republic of Letters*, ed. Mordechai Feingold (Cambridge: The MIT Press, 2003), pp. 389–432; Mordechai Feingold, ed., *The New Science and Jesuit Science: Seventeenth Century Perspectives* (Dordrecht: Springer-Science+Business Media, B.V, 2003); Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773". There is also the case of Paula Findlen, "Living in the Shadow of Galileo: Antonio Baldigiani (1647–1711), a Jesuit Scientist in Late Seventeenth-Century Rome", in *Conflicting Duties: Science, Medicine and Religion in Rome, 1550–1750*, ed. Maria Pia Donato and Jill Kraye (London and Turin: The Warburg Institute / Nino Aragno Editore, 2009), pp. 211–254, employing 'Jesuit scientist' as both a variation and an anachronism.

83. Some exemplary titles are Renée J. Raphael, "Copernicanism in the Classroom: Jesuit Natural Philosophy and Mathematics after 1633", *Journal for the history of astronomy*, no. 46 (4) (2015): pp. 419–440, Noël Golvers, "F. Verbiest's mathematical formation. Some observations on post-Clavian Jesuit mathematics in mid-17th century Europe", *Archives internationales d'histoire des sciences* 54 (2004): pp. 29–47, and Peter Dear, "Jesuit mathematical science and the reconstitution of experience in the early seventeenth century", *Studies in History and Philosophy of Science* 8 (2 1987): pp. 133–175.

84. Alfredo Dinis, "Giovanni Battista Riccioli and the Science of His Time", in *Jesuit Science and the Republic of Letters*, ed. Mordechai Feingold (Cambridge: The MIT Press, 2003), pp. 195–224.

85. Ibid., pp. 433–434.

86. Concerning particularly the concept of Jesuit tradition in science, Agustín Udías, "Jesuit Scientific Tradition and Ignatian Spirituality", *Lo Sguardo – Rivista di filosofia* 3, no. 10 (2012): pp. 207–219, offers a brief introduction that goes beyond the early modern period and also traces the development of Jesuit activitites after the reinstitution of the order in 1814.

In his few but insightful publications, historian of science Steven Harris devotes himself to these questions. His PhD thesis from 1988 is a study on how early modern science became a valid activity for Jesuits, which form this activity assumed, and especially how "the values, attitudes, goals, and institutions of the Society contribute[d] to the establishment of the dominant scientific traditions within the order".[87] These values, attitudes, goals, and institutions make up what Harris subsumes as the Jesuit ideology,[88] characterized by eight major themes:

> "1) the universal (or global) context Ignatius [of Loyola] envisioned for his order; 2) the fundamental respect for the uniqueness and individuality of persons; 3) the elitist role reserved for members of the Society as cultural and spiritual elite (i.e. as highly educated priests trained to be the 'fellow-workers of Christ'); 4) the esteem of 'ratio' (or divine reason) and the desire to work towards its realization through system, method, and order as well as through learning; 5) a purposeful, goal-oriented attitude guided by the Ignatian utilitarian principle ('for the greater glory of God'); 6) the valuation of diligence, industry, and efficiency; 7) the insistence on testing persons and methods 'against experience'; 8) and demonstrated adaptability in thought and action"[89]

Harris himself points out that there is reason for conflict inherent in these ideals, such as the stated value of the individual clashing with the Society's demand for obedience. While this issue is obvious, he also names two fundamental concepts to Jesuit thought whose ramifications for Jesuit activity in the early modern sciences are not immediately clear, namely the esteem of divine reason and testing methods against experience. In order to understand these concepts, it seems best to consider an example of a contemporary mode of their propagation: frontispieces.

A type of title engraving, frontispieces are full-page allegorical illustrations that can mostly be found facing the title page in books printed in the early modern period. While technically still existing today, they only appear in a very downscaled manner if at all; an anniversary edition, for example, might show an image of the jubilarian before the title page. The heyday of the frontispiece, however, was in the seventeenth century, when it was more than just a decorative element. Usually carefully designed to follow

87. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", p. 13.
88. Harris treats the topic of Jesuit ideology extensively in the second and fourth chapters of his dissertation, and provides a very condensed description in his follow-up paper "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition" on pp. 31–32.
89. Ibid., p. 103.

an agenda, frontispieces fulfilled a plethora of roles: display of patronage, display of prowess and influence, self-advertisement, legitimization, visual table of contents, they were even removed from the printed works they belonged to and "functioned as gifts and collectible items",[90] a hint at the fact that the intended audiences of a book and its frontispiece were not necessarily the same.

Figure 2.1 on Page 37 now shows the frontispiece to Jesuit Christoph Scheiner's (1537–1650) *Rosa ursina sive sol* (The Orsini rose or the sun), a tract on the theory of sunspots published in 1630 and based on his astronomical observations made during the 1610s and 1620s.[91] The image contains multiple layers of meaning and deals with the major themes of patronage, cosmology, and Jesuit epistemology.[92] The latter is expressed mainly by the four corner vignettes of the frontispiece, depicting *auctoritas sacra* in the top left, the sacred authority or authority of the Scripture which binds all human recognition; *ratio* in the top right, divine reason which is the guiding force of human recognition; *auctoritas profana* in the bottom left, the profane authority or authority of philosophy which in turn is subject to Scripture; and *sensus* in the bottom right, human perception that, on its own, cannot be clear. This establishes two 'planes' of insight—one heavenly, guided and illuminated, but bound by divine hand, the other earthly, determined by practical human experience, deduction, as well as a lack of definite clarity. The first, also visually superior plane, corresponds with the Jesuit esteem for divine reason, while the second, visually inferior, mirrors the Jesuit ideal of testing against experience and having experience in the first place.

Through this imagery, the frontispiece conveys the sentiment that "the evidence of the senses, unless illuminated by [divine] reason and natural philosophy, is insufficient to contradict Scripture",[93] and especially that the "assistance of divine light is required to make sense of the senses, to produce understanding in the intellect".[94] In other words, human gain of knowledge is only possible under God's instruction and direction, and hence cannot disagree with biblical exegesis and the theological sentences of the Church fathers—if it disagreed, it necessarily must be wrong and had to be adapted in some way. What is more, evidence of the senses is obtained by empirical observation, and since

90. Volker Remmert, *Picturing the Scientific Revolution* (Philadelphia: Saint Joseph's University Press, 2011), p. 11.
91. A. Ziggelaar, "Scheiner, Christoph", in *Diccionario Histórico de la Compañía de Jesús*, ed. Charles O'Neill et al., vol. IV (Madrid: Universidad Pontifica Comillas, 2001), cols. 3517–3518.
92. An in-depth explanation of the frontispiece can be found in Remmert, *Picturing the Scientific Revolution*, pp. 69–74 and 203–208.
93. William B. Ashworth, Jr., "Light of Reason, Light of Nature: Catholic and Protestant Metaphors of Scientific Knowledge", *Science in Context* 3, no. 1 (1989): p. 96.
94. Ibid., p. 97.

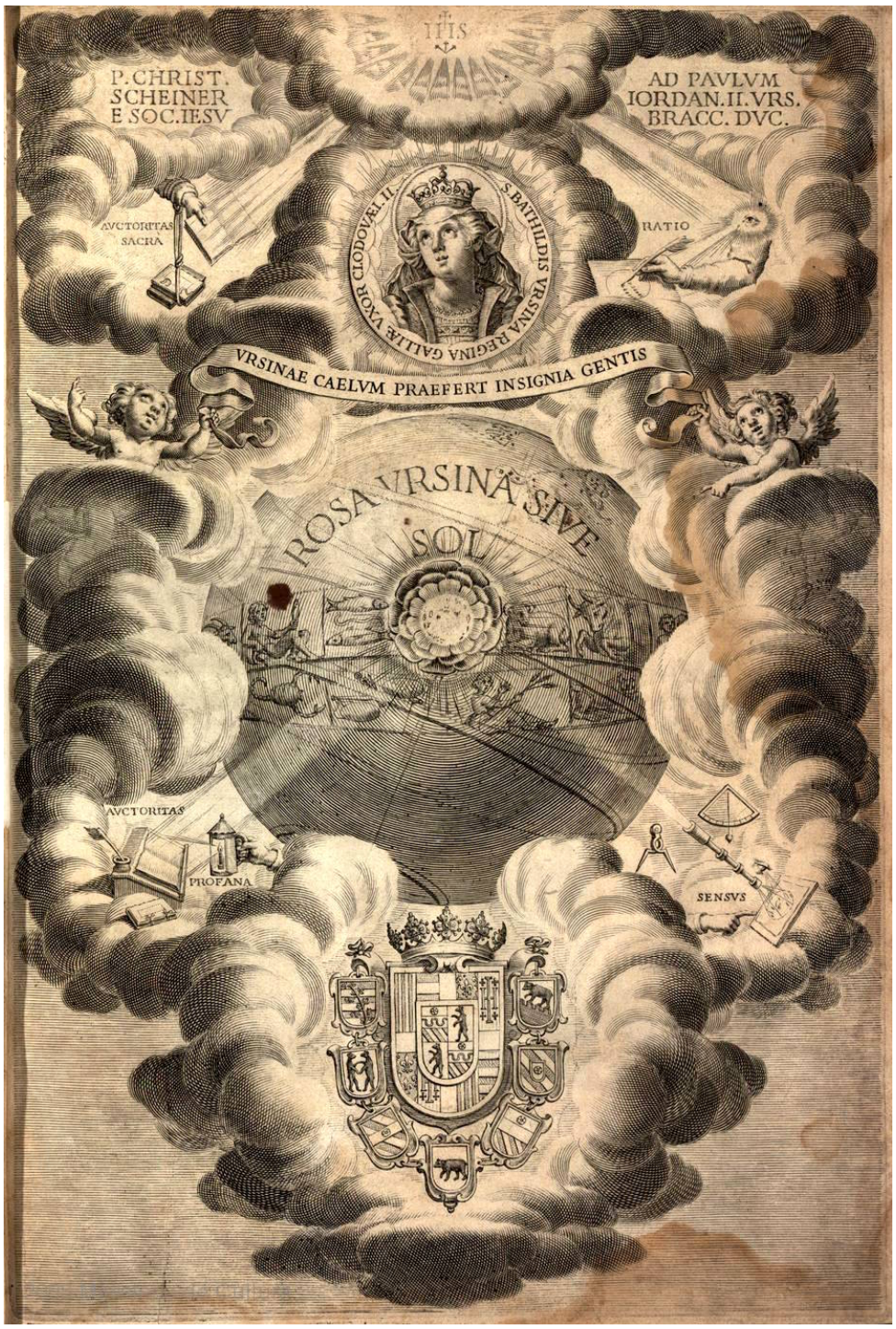


Figure 2.1.: Frontispiece to Christoph Scheiner's *Rosa Ursina Sive Sol* (1630). Source: Biblioteca Virtual del Patrimonio Bibliográfico (CC BY 4.0).

empirical observation was linked to manual labor and thus disregarded, it inherently could not hold up to natural philosophy and provide proper reasoning.[95] At a time when human experience began to increasingly disagree with the prevalent interpretation of the Bible, this position, still held by many of Scheiner's confrères,[96] became increasingly problematic.

The largest-scale example in this context is probably the early modern cosmological debate over the geocentric and heliocentric systems.[97] Again looking to the frontispiece of the *Rosa ursina* allows to learn about the official Jesuit stance. With the Earth in the center of the image, and the sun[98] as just one of the stars on the zodiac band surrounding the globe, the imagery contains a clear statement in affirmation of geocentrism. Upholding this tenet along with the described epistemology was vital to the Society's *unitas et uniformitas doctrinae*, the unity and uniformity of doctrine representing "a strict interdependence between theology, metaphysics, physics, and mathematics, which was considered essential for its religious policy"[99]. Founding father Ignatius of Loyola stressed the importance of such a unity on multiple occasions in the order's constitutional documents,[100] with the ultimate goal being "to maintain orthodoxy, eliminate squabbles and facilitate obedience".[101] The Jesuits initially taught the heliocentric system in their colleges with the aim to refute it, often engaging in polemics to discredit both the theory and its proponents, but only helped spread it further instead. As the astronomical observations became more precise and the mathematical and physical theories more refined, there were less and less arguments available based on Aristotelian *scientia* until the only arguments left were of theological nature. At this point, heliocentrism became the "best hypothesis, its acceptance banned solely by the Roman interdiction".[102]

95. On Edgar Zilsel's account on early modern university-scholars and artist-engineers, refer to page 22.

96. Remmert, *Picturing the Scientific Revolution*, p. 72.

97. On pp. 35–40, Agustín Udías, *Jesuit Contribution to Science* (Cham: Springer, 2015), provides a summary of this topic with a focus on the Jesuits.

98. As a tribute to Scheiner's patrons, the Orsini family, the sun has the form of the heraldic Orsini rose. The family crest is also shown at the bottom of the frontispiece.

99. Ugo Baldini, "The Academy of Mathematics of the Collegio Romano from 1553 to 1612", in *Jesuit Science and the Republic of Letters*, ed. Mordechai Feingold (Cambridge: The MIT Press, 2003), p. 64.

100. Ugo Baldini, *Legem impone subactis : Studi su filosofia e scienza dei Gesuiti in Italia : 1540–1632* (Roma: Bulzoni Editore, 1992), describes the character and context of the unity ideal in detail, especially on pp. 78–82.

101. Marcus Hellyer, "'Because the Authority of My Superiors Commands': Censorship, Physics and the German Jesuits", *Early Science and Medicine* 1 (3 1996): p. 320.

102. Barbara Bieńkowska, "From negation to acceptance : The reception of the heliocentric theory in Polish Schools in the 17th and 18th centuries", in *The reception of Copernicus' heliocentric theory : Proceedings of a symposium organized by the Nicolas Copernicus Committee of the International Union of the History and Philosophy of Science*, ed. Jerzy Dobrzycki (Dordrecht: Reidel, 1972), p. 94. The paper offers an exemplary study of how heliocentrism became accepted in Polish schools, including a very insightful look at the teaching practices

However, this gradual 'acceptance' was not unique to the Jesuits. Not only in Polish schools, for instance, was heliocentrism first "presented as a new system, from the logical point of view absurd and erroneous as inconsistent with the 'letter' of the Bible, later as a probable hypothesis, then as a perfect hypothesis, and finally as the only true system of the universe."[103] The particularities of the Jesuit-scholar, in turn, meant that "[a]s experts, the Jesuit mathematicians admitted the conceptual validity and factual truth of numerous new results and conceptions; as Jesuits, they attempted to interpret these in such a way as to preserve the chain and the cognitive status of all its constituents, through a suitable redefinition of their relationships,"[104] as Ugo Baldini summarizes it in his study on the so called Academy of Mathematics at the Jesuit college in Rome. Similarly, Steven Harris states that the "Jesuits were heavily engaged in the empirical and experimental aspects of early modern science while preserving (and transforming) traditional Aristotelian natural philosophy".[105]

In order to remain in control of this involvement in the early modern sciences and ensure compliance with *unitas et uniformitas* on all fronts, the Society of Jesus utilized internal censorship.[106] On a conceptual level, censorship had to determine which opinions and teachings were acceptable and which were not, and make them known within the Society; on a practical level, it had to monitor whether the standards—which could always fall subject to change—were followed.[107] Warranting that all approved publications were not only well written in terms of content, but also in terms of form and style, censorship furthermore functioned as the Jesuit quality control. As such, it was contributing to preserve the ideal of the Society as an intellectual elite.[108]

But the involved bureaucracy could also prove helpful as it assisted aspiring Jesuit

at Jesuit colleges on pp. 90–98.

103. Ibid., p. 79.

104. Baldini, "The Academy of Mathematics of the Collegio Romano from 1553 to 1612", p. 69.

105. Harris, "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition", p. 31.

106. A very brief explanation of how Jesuit censorship worked can be found in Friedrich, *Die Jesuiten*, pp. 308–311, with an in-depth discussion given in Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", pp. 107–129. For specific examples of censorship and how Jesuit scholars dealt with it, see: Harald Siebert, "Kircher and His Critics: Censorial Practice and Pragmatic Disregard in the Society of Jesus", in *Athanasius Kircher: the last man who knew everything*, ed. Paula Findlen (New York: Routledge, 2004), pp. 105–132; chapter 5 on "Discipline and Authority" in Findlen, "Living in the Shadow of Galileo: Antonio Baldigiani (1647–1711), a Jesuit Scientist in Late Seventeenth-Century Rome"; Michael John Gorman, "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670" (PhD diss., European University Instutute, 1998); and Hellyer, "'Because the Authority of My Superiors Commands': Censorship, Physics and the German Jesuits".

107. Ibid., p. 322. On the topic of a 1651 list detailing forbidden thought, see pp. 326–335.

108. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", pp. 119–120.

authors with the acquisition of patronage, passed along already established connections, and facilitated the exchange of ideas and experiences with other Jesuit authors. Those in geographically isolated places or places far from important and central Jesuit hubs were especially in need of such support.[109] As each author was responsible for finding the means to publish his book himself, being able to draw on internal networks was vital.[110]

Regarding the factual literary output by members of the Society of Jesus, Steven Harris carried out a statistical analysis of the numbers of overall writings, writings in the early modern sciences, and their respective authors for his PhD thesis. This work, along with one of his subsequent papers, belong to the foundations upon which the Jesuit Science Network is built; because of that, I will settle for the results for the time being and address the details later on in Section 2.4.2.[111]

In his study, Harris discerns the main subject categories theology, law, philosophy, history, sciences, and arts and letters. Concerning the overall development in all of these, he observes a slow increase between 1540 and 1580, then a rapid growth until 1620 followed by a more or less steady output until 1800, although he finds the levels slightly decreased between 1660 and 1720.[112] With regards to the proportions of the particular subjects, the year 1700 appears to be a turning point. Before, theology accounted to 40 percent of all literary output, history to 28 percent, arts and letters to 20 percent, sciences to 6 percent, philosophy to 5 percent, and law to 2 percent; after, theology dropped to 32 percent, history to 26 percent, and philosophy to 3 percent, while law stayed the same at 2 percent and sciences more than doubled to 13 percent.[113]

Harris calls the growth in publications in early modern science after 1700 "astounding",[114] though cautions against reading too much into it—the sciences still barely averaged one tenth of the total literary production. It is only with the background of the internal censorship that "tallies of scientific publications may serve not merely as an index of Jesuits' collective scientific interests, but also as an indication of the Society's cultural views".[115] In conclusion: "Thus the appearance of published works in the mathematical and natural sciences ought not to be viewed merely as evidence of indifference or passive tolerance. Rather, it is an indication of the Society's positive valuation of that

109. Martha Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century", in *Jesuit Science And The Republic Of Letters*, ed. Mordechai Feingold (Cambridge: The MIT Press, 2003), p. 292.
110. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", p. 107.
111. Ibid., the statistical evaluation and its discussion begin on pp. 130–179 while the accompanying graphs are on pp. 310–453.
112. Ibid., p. 133, graph A-2 on p. 311.
113. Ibid., p. 134, graph A-1 on p. 310.
114. Ibid., p. 137.
115. Ibid., pp. 127–128.

particular field of interest as a worthy, proper, and suitable undertaking for a particular member of the Society."[116]

The remaining task is now to relate all of these observations to the character of Jesuit science.

In the beginning, Jesuit science appeared as a fixed, yet strangely undefined term. The first indirect explanation equated it to the Jesuit tradition in the early modern sciences, the Jesuit way of searching for truth. As such, Jesuit science naturally had to live up to and embody Jesuit ideology; the potential for conflict inherent to this ideology consequently carried over to Jesuit activities in the early modern sciences. The Society's internal censorship, dictating which subjects and positions were appropriate and carefully watching over the members' compliance with the rules, ensured the unity and uniformity of doctrine in this regard and contributed to the intended image of the order as an intellectual elite. Teaching, presented as one of the central ministries in the previous section, was one way in which this ideal found an expression; another was the production of manuscripts and publications. Although the early modern sciences turned out to be only a minor area of engagement, their pursuit was nonetheless valued and esteemed within the Society.

All things considered, I would like to propose a definition of Jesuit science as the scholarly activity of members of the Society of Jesus in the early modern sciences, an activity consisting of generating, consolidating, discussing, and teaching knowledge in the associated subjects within a regulated religious community and under a larger philosophical and theological framework. In many areas, this activity did not differ from the work of non-religious scholars, and just like them, Jesuits had the liberty to consider and agree with theories outside of their predefined set of beliefs.

It is finally the aim of the Jesuit Science Network to record and display the real-life scope of this Jesuit science, making it more concrete and tangible in its factual performance.

2.2.3. Story detail: From the *Constitutiones Societatis Iesu* (1558) to the *Ratio Studiorum* (1599)

To round off this brief portrayal of the Society of Jesus in the early modern period, I would now like to take a more particular look at the beginnings of the Jesuit educational endeavor and especially the place that the sciences, here by the example of mathemat-

116. Ibid., p. 129.

ics,[117] were assigned in these early days. The period in focus is distinguished by two foundational documents: the *Constitutiones Societatis Iesu*, the Jesuit Constitutions of 1558, and the *Ratio Studiorum*, the Jesuit regulations of study of 1599. My aim is to shed some light on the institutional aspect of Jesuit teaching, to examine the status that the documents assigned to mathematics, and present some early Jesuit mathematicians as well as their attempts to promote their main field of activity.

The beginnings of Jesuit teaching and the place of mathematics in the Jesuit Constitutions

Jesuit founding father Ignatius of Loyola and his companions intended for the Society to become involved with education from the very start, albeit their plans were far less ambitious in comparison to the extent that Jesuit schooling eventually reached. Already the *Formula Instituti* (Rules of the enterprise) from 1539, drafting the principles for the future Society of Jesus, names public schooling as one of its fundamental tasks.[118] Each Jesuit should strive towards "the progress of the souls in a Christian life and doctrine and the propagation of the faith through public lectures, the ministries of the word of God, spiritual exercises, works of goodwill, and the teaching of the young boys and the uneducated in Christianity, as well as through the hearing of confessions and spiritual consolations of the believers in Christ".[119] The teaching meant here obviously refers to the Catholic catechism, but some of the early Jesuits intermittently came to lecture theology at established universities or teach skills such as reading and writing at a missionary station in Goa, where they eventually took on the entire organization. In the light of these first experiences, the emerging necessity to also provide instructions for the order's own progeny did not come as a total surprise.[120] Because of its vow of poverty and overall lack of funding, however, the Society was—and remained—dependent on outside financial support. The first Jesuit colleges in Gandía, Spain, and Messina, Italy, hence came into existence when the respective leaders arranged for the provision and maintenance of the necessary board and lodging in their cities in return for the Jesuits

117. Having addressed the difficulties in terminology in Section 2.3.1, I will use terms such as 'mathematics' or 'mathematician' without any further explanations from now on. An early modern context is always assumed.
118. O'Malley, *The First Jesuits*, p. 5.
119. "[A]d profectum animarum in uita et doctrina Christiana, et ad fidei propagationem per publicas praelectiones et uerbi Dei ministerium, spiritualia exercitia et charitatis opera, et nominatim per puerorum ac rudium in christianismo institutionem, ac Christifidelium in confessionibus audiendis, spiritualem consolationem" Paul III, "Bulla Prima Pauli III", in *Monumenta Ignatiana ex autographis vel ex antiquioribus exemplis collecta*, vol. I (Roma: Institutum Historicum Societatis Iesu, 1934 [1540]), p. 26.
120. O'Malley, *The First Jesuits*, pp. 201–203.

teaching their children and the children of their subjects. The lectures began in Gandía in 1546 and in Messina two years later.[121]

Of these two, Messina is the more interesting case since it became the prototype after which many Jesuit colleges were modeled in the sixteenth century. Loyola hand-picked "some of the best talent available to him in Rome"[122] to set up the new institution, among them his confidant Jerónimo Nadal (1507–1580), a trained mathematician who was voted the first rector of the Messina college by the dispatched group. In this position, he was not only tasked with setting up the instruction at his college, but moreover responsible for the overall success of this first Jesuit step towards organized education.

Since the Society had only been founded eight years prior, the events surrounding the Messina college were taking place at a time when Ignatius of Loyola was still occupied with extending the basic principles from the *Formula* into a full-fledged Jesuit constitution. Even with the help of Loyola's confrère and secretary Juan Alfonso de Polanco (1517–1576), the *Constitutiones Societatis Iesu*[123] (Constitutions of Society of Jesus) were not published until 1558, two years after Loyola's death. The Constitutions lay out the guiding conventions and regulations for the life and work within the order by sketching the way that a Jesuit would take "from the moment he applied to be a member of the Society, through his training, up to the ministries in which he would engage, and they conclude with considerations concerning the qualities of the superior general and of the body of the Society as a whole".[124] Under the impressions of the beginning Jesuit involvement with education, the aforementioned ministries notably include the work of a teacher.

Part IV of the *Constitutiones* is hence devoted to Loyola's notion of the general character of Jesuit teaching, taking up 70 out of the 309 pages of the entire document. It deals with practical aspects of leading a school, the duties and requirements assigned to both teachers and students, and also some guidelines for the content to be treated in the lessons.[125] The already mentioned use of public disputations, theater, art, and music as one of the cornerstones of Jesuit education in Section 2.2.1, for example, goes back to an idea laid out by Loyola in the Constitutions.[126] However, neither this nor any

121. Ibid., pp. 203–204.
122. Ibid., p. 204.
123. *Constitutiones Societatis Iesu. Cum earum Declarationibus.* (Romae: In collegio Romano eiusdem Societatis, 1615).
124. O'Malley, *The First Jesuits*, p. 7.
125. Pars IV., *Constitutiones Societatis Iesu*, pp. 112–178. More information on the context and development of Loyola's educational plans can be found in George E. Ganss, *Saint Ignatius' Idea of a Jesuit University* (Milwaukee: Marquette University Press, 1954).
126. See *Constitutiones Societatis Iesu*, pp. 161–162; reference after Dennis C. Smolarski, "The Jesuit Ratio

other part provides an actual curriculum; the founding father stipulated instead that a proper teaching program was to be drafted at a later time once the Society had gained enough experience. I will with the resulting document, the so called *Ratio atque Institutio Studiorum Societatis Iesu* (Method and system of the studies of the Society of Jesus) of 1599, later in this subsection.

Albeit the Constitutions lack details, they contain a brief listing with the designated subjects of future Jesuit instruction under the title *De Scientiis Quae tradendae sunt in Universitatibus Societatis* (On the sciences to be treated in the universities of the Society) in chapter XII.[127] Like the entirety of the document, this chapter features a tripartite formatting: The main text (actual content, upright font) and a margin text (short explanations, italic font) make out the line width; the actual page margin then contains references to other pages and chapters (upright font, smaller font size). The very first sentence of the main text of chapter XII contains a description of the Jesuit self-image:

> "As it is the aim of the Society and its studies to assist our neighbors with knowing and loving God and saving their souls; and as the most appropriate way to do this is by means of theology; to this should the universities of the Society apply themselves above all."[128]

The self-imposed apostolic mission of the Society to help those around them in their search for God and salvation is thus also reflected on a conceptional level, with theology placed at the very center—or beginning—of the proposed Jesuit educational endeavor. Other subjects are related to theology by their contents or use and ranked accordingly.[129] Scholastic doctrine, Bible study, and positive theology are named first, then the necessity of knowing Latin, Greek, Hebrew, and possibly Chaldaic for both theoretical and practical exercises in theology is pointed out. The margin text finally comments on Turkish, Arabic, and Indian languages also being useful to learn as a prerequisite for a successful mission in the respective areas.

The subsequent part of the main text then states that

Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities", *Science in Context* 15, no. 3 (2002): pp. 447–448.

127. *Constitutiones Societatis Iesu*, pp. 159–161.

128. "*Cum Societatis atque studiorum scopus sit, proximos ad cognitionem et amorem Dei, et salutem suarum animarum iuvare; cumque ad eum finem, medium magis proprium sit facultas Theologiae; in hanc potissimum Societatis Vniuersitates incumbent*", ibid., p. 159.

129. Consider also the discussion of this part in Giuseppe Cosentino, "Mathematics in the Jesuit Ratio Studiorum", in *Church, culture, and curriculum: theology and mathematics in the Ratio studiorum*, ed. Frederick A. Homann (Philadelphia: Saint Joseph's University Press, 1999), pp. 53–54.

> "even the arts or natural sciences prepare the characters for theology, and serve towards its perfect understanding and use, and help through themselves to this end; they should be treated by learned teachers and with diligence, sincerely seeking the honor and glory of God in everything".[130]

The natural sciences are hence included in the spheres of knowledge that are acceptable for Jesuits to know about, pursue, and practice. At the same time, however, they are restricted to being a means to an end and explicitly subordinated to theology; this distinction appears remarkable insofar as it is not made so clearly for any other subject. The margin text, in fact, contains a specific qualification concerning mathematics:

> "Logic, physics, metaphysics, and moral sciences shall be treated, and even mathematics, as much as they can help further our proposed goals."[131]

In addition to running a poor second, it was pointed out by Dennis Smolarski that the sentence structure and choice of vocabulary in the Latin original furthermore emphasize the denigration of the mathematical sciences.[132]

Let me now conclude the examination of this part of the *Constitutiones*. A last look at chapter XII reveals that grammar, rhetoric, poetics, and history are naturally approved subjects for Jesuit instruction, while the study of medicine and law is prohibited.[133] A later chapter titled *De Libris Qui praelegendi sunt* (On the books to be read) finally offers guidance on the intellectual authorities to be followed in Jesuit schooling. The chapter gives only two names, Thomas Aquinas (1225–1274) for theology and Aristotle for philosophy, and leaves the choice of any other literature up to the discretion of the

130. "*Sic etiam quoniam Artes, vel Scientiae naturales ingenia disponunt ad Theologiam, et ad perfectam cognitionem et vsum illius inseruiunt, et per se ipsas ad eundem finem iuuant; qua diligentia par est, et per eruditos Praeceptores, in omnibus syncere honorem et gloriam Dei quaerendo, tractentur*", *Constitutiones Societatis Iesu*, p. 160.

131. "*Tractabitur Logica, Physica, Metaphysica, Moralis scientia, et etiam Mathematicae, quatenus tamen ad finem nobis propositum conueniunt*", ibid., pp. 160–161.

132. Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities", p. 453.

133. The prohibition of medicine did not apply to infirmaries and pharmacies as parts of Jesuit institutions. Members of the Society also inadvertently picked up some practical medical knowledge when going to hospitals in order to tend to the sick, a ministry taken up by the order early on. What is more, a certain medical understanding was vital for Jesuit missionaries since they had to be able to take care of themselves in case of sickness and injury. In 1576, the Society was eventually allowed by the Pope to practice medicine should no other doctors be available, see O'Malley, *The First Jesuits*, p. 172. Medical botany was similarly essential to the health (both financial and physical) of Jesuit missionaries and thus practiced fairly consistently, see Harris, "Jesuit Scientific Activity in the Overseas Missions, 1540–1773", p. 73. Finally, Christoph Sander, "Medical Topics in the *De anima* Commentary of Coimbra (1598) and the Jesuits' Attitude towards Medicine in Education and Natural Philosophy", *Early Science and Medicine* 19 (2014): pp. 76–101, takes a closer look at the Jesuit stance towards medical topics with a particular focus on the teaching practices at the college in Coimbra.

teacher. Despite the fact that the passage furthermore sets up the rector of a college as the final deciding instance, this leaves a surprising amount of individual freedom within the classroom.[134]

First mathematical programs

This individual freedom becomes apparent in the efforts of the already introduced Jerónimo Nadal, the first rector of the Jesuit college in Messina. As part of his task to organize the instruction and set up a curriculum, Nadal also conceived—in the same year that the college was founded, 1548—a "brief and specific mathematics program"[135]. The general curriculum along with the specific mathematics part were approved by Loyola with few changes and served as blueprints for other Jesuit colleges.[136] Based on this first plan, in 1552 Nadal compiled a second, extended version of his ideas for mathematical instruction within the Society and hoped to have it included in the *Constitutiones*, but did not succeed with this intention.[137] It still provided a basis for the curriculum of the most important Jesuit college, the central *Collegium Romanum* established 1551 in Rome, but even this downgraded version turned out too demanding for practice: the Jesuits lacked members with an appropriate training in mathematics.[138] In actuality, the Jesuits lacked members with an appropriate training in general, and those with specializations in subjects such as the sciences had to take over the instruction of basics such as theology and philosophy, or attend to the order's organization.[139] This shortage of teaching staff remained a regularly occurring issue for Jesuit colleges in the early modern period; Nadal leaving Messina in 1553, for instance, also left the college without courses in mathematics.[140] In Chapter 4, I will address this phenomenon again as one of the factors in the demise of Jesuit mathematical education in the Polish-Lithuanian Commonwealth, but I will also explore the measures taken against it.

With Nadal's plans being too ambitious for the Society's capabilities and intentions, the task of actually establishing the mathematical studies at the *Collegium Romanum* fell to Baltasar de Torres (1518–1561), the first Jesuit assigned with teaching mathematics in

134. *Constitutiones Societatis Iesu*, Pars IV. Cap. XIV.3, p. 167.
135. Cosentino, "Mathematics in the Jesuit Ratio Studiorum", p. 49.
136. Ibid., p. 52.
137. More context and a detailed account of the contents of Nadal's plan can be found in Romano Gatto, "Christoph Clavius' 'Ordo Servandus in Addiscendis Disciplinis Mathematicis' and the Teaching of Mathematics in Jesuit Colleges at the Beginning of the Modern Era", *Science & Education* 15 (2006): p. 237, and Cosentino, "Mathematics in the Jesuit Ratio Studiorum", pp. 49–51.
138. Cosentino, "Mathematics in the Jesuit Ratio Studiorum", p. 52.
139. Gatto, "Christoph Clavius' 'Ordo Servandus'", p. 238.
140. Ibid., p. 237.

Rome. Torres held the chair in mathematics from 1553, shortly after he had entered the Society, until his death, and was also tasked with giving lessons in philosophy. Prior to his engagement with the order, he had worked as the physician of the Sicilian viceroy. This position had allowed him to build a collection of books and scientific instruments for both his medical and mathematical interests that proved invaluable for his later work in the Society.[141]

Aside from publishing the curriculum for his mathematics classes at the Roman college,[142] Torres also drafted up two programs for longer and more comprehensive mathematical courses.[143] The second one is remarkable insofar as it proposed to allow certain students to continue their mathematical studies after completing the basics, a "real novelty".[144] In theory, this could have helped keep up consistent mathematics instruction in Jesuit colleges, but in reality, the lack of specialized instructors would have made it almost impossible to implement.

Promoting and defending the mathematical sciences within the Society: Christoph Clavius

What is more, Torres developed this curriculum together with his student and later successor Christoph Clavius (1537–1612), whom Augustín Udías identifies as the actual "beginning of the scientific tradition of the Society of Jesus".[145]

Clavius gained fame as a teacher, author, compiler, and commentator.[146] He first made a name for himself with a commentary on the Sphere of Sacrobosco, first published in 1570, and especially a very successful commentary on Euclid's Elements, first published in 1574. The *Euclidis elementorum libri XV* (Fifteen books of Euclid's Elements) saw five reprints and were translated into Chinese by Matteo Ricci (1552–1610), one of Clavius' many students and one of the founding fathers of the Jesuit mission in China.[147] The

141. C. de Dalmases, "Torres, Baltasar de (I)", in *Diccionario histórico de la Compañía de Jesús*, ed. Charles O'Neill, vol. IV (Madrid: Universidad Pontifica Comillas, 2001), col. 3818.
142. Balthasar de Torres, "Ordo lectionis matheseos in Collegio Romano", in *Monumenta Paedagogica Societatis Iesu*, ed. Ladislaus Lukács, vol. II (Roma: Institutum Historicum Societatis Iesu, 1974 [1557–1560]), p. 433.
143. Gatto, "Christoph Clavius' 'Ordo Servandus'", pp. 237–238.
144. Ibid., p. 238.
145. Udías, *Jesuit Contribution to Science*, p. 4.
146. Peter Engelfriet, *Euclid in China. The Genesis of the First Translation of Euclid's Elements in 1607 & its Reception up to 1723* (Leiden: Brill, 1998), p. 47. For the discourse to follow, I am necessarily sticking to those aspects of Clavius' work and the treatment of mathematics within the Society of Jesus that seem most important to me; for an extended account with many additional references, I would like to recommend "Chapter Two: Mathematics in Jesuit Context" (pp. 11–55) in Englfriet.
147. For more information on the importance and reception of this translation and the spread of Euclidean knowledge in China in general, see Engelfriet, *Euclid in China*. Concerning Clavius as a teacher, Baldini,

edition of the Elements led to contemporaries calling Clavius the Euclid of his times,[148] and was also very favorably mentioned by Abraham Gotthelf Kästner (1719–1800) in his *Anfangsgründe* and Moritz Cantor (1829–1920) in his *Vorlesungen*.[149]

Another "principal source of his fame"[150] was Clavius' contribution to the Gregorian calendar reform. Despite still being very early in his career at the time, he was called upon as one of the two technical advisors to the papal commission working on the reform; it began its work between 1572 and 1575. Clavius' task was initially only to assess the proposed alternatives, but after the reform was enacted by papal bull, he became its main announcer and published seven books in order to explain and defend the new system. Although the reform was not accepted without controversy,[151] and especially Protestant and Eastern-Orthodox monarchs adopted it only very hesitantly—while the Catholic Netherlands, for instance, switched to the Gregorian calendar just after its announcement, the Protestant Netherlands did so only in 1700[152]—Michael John Gorman concludes that "it is difficult to overstate the degree of legitimation which

"The Academy of Mathematics of the Collegio Romano from 1553 to 1612", deals with the already mentioned specialized mathematical school that he set up. Finally, Gorman, "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670", pp. 35–43, sheds light on Clavius' disciples and their continuation of his work.

148. His confrère Louis Richeome (1544–1625), for example, wrote about the "grand Christofle Clavius, l'Euclid et l'Archimede de nos siecles". Louis Richeome, *La peinture spirituelle* (1611), p. 499.

149. Abraham Gotthelf Kästner, *Anfangsgründe der Mathematik / 1,1: Anfangsgründe der Arithmetik, Geometrie, ebenen und sphärischen Trigonometrie und Perspectiv*, Vierte vermehrte Auflage (Göttingen: Vandenhoek, 1786), p. 425; Moritz Cantor, *Vorlesungen über Geschichte der Mathematik*, Zweite Auflage, vol. 2 (Leipzig: B. G. Teubner, 1900), pp. 555-556.

150. James M. Lattis, *Between Copernicus and Galileo* (Chicago: The University of Chicago Press, 1994), p. 20. Most of the information of this paragraph is taken from here, pp. 20–21. For an extensive treatment on the historical background, the involved persons, some astronomical aspects, and the reception of the reform, see the collected papers in G. V. Coyne, M. A. Hoskin, and O. Pedersen, eds., *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982* (Pontificia Academia Scientarum, Specola Vaticana, 1983).

151. For example, see Gorman, "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670", pp. 22–27; H. M. Nobis, "The Reaction of Astronomers to the Gregorian Calendar", in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, ed. G. V. Coyne, M. A. Hoskin, and O. Pedersen (Pontificia Academia Scientarum, Specola Vaticana, 1983), pp. 243–254; M. A. Hoskin, "The Reception of the Calendar by Other Churches", in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, ed. G. V. Coyne, M. A. Hoskin, and O. Pedersen (Pontificia Academia Scientarum, Specola Vaticana, 1983), pp. 255–264; O. Gingerich, "The Civil Reception of the Gregorian Calendar", in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, ed. G. V. Coyne, M. A. Hoskin, and O. Pedersen (Pontificia Academia Scientarum, Specola Vaticana, 1983), pp. 265–279; K. Fischer, "Appended Note: On the Calendar Reform in Bohemia and Moravia", in *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, ed. G. V. Coyne, M. A. Hoskin, and O. Pedersen (Pontificia Academia Scientarum, Specola Vaticana, 1983), pp. 281–284.

152. A table listing the years in which certain countries adopted the Gregorian calender can be found in Edward L. Cohen, "Adoption and Reform of the Gregorian Calendar", *Math Horizons* 7, no. 3 (2000): p. 6.

calendar reform conferred on astronomical, and hence mathematical, practices within the post-Tridentine church".[153] Contributing to the reform hence earned Clavius great esteem and strengthened his position as a mathematician both within and outside the Society of Jesus, indispensable for his advocating for the mathematical sciences.

Roughly around the time when the first edition of the *Euclidis elementorum libri XV* appeared, Clavius in particular involved himself in the *Quaestio de certitudine mathematicarum* (Question about the certitude of mathematics), a sixteenth century debate on whether mathematics—or, to be more precise, Euclid's geometry—was indeed an Aristotelian science or not.[154] Without going into detail, a major problem was seen in the fact that geometrical proofs do not take the form of syllogisms, a property required by Aristotle's conception of science.[155] Many philosophers still considered them to be equal, resulting in a tacit agreement about accepting mathematics among the *scientiae*.[156]

This changed in 1547 with Italian scholar Alessandro Piccolomini's (1508–1578) treatise *Commentarium de Certitudine Mathematicarum Disciplinarum* (Comment on the certainty of the mathematical disciplines), wherein he vehemently argued that geometrical proofs did not fulfill Aristotle's requirements.[157] The debate influenced many scholars during the remaining sixteenth and the following seventeenth century.[158] Among those who weighed in are Marin Mersenne (1588–1648), John Wallis (1616–1703), and Isaac Barrow (1630–1677) defending mathematics, while one of the loudest voices for the opposition belonged to a Jesuit, the influential philosopher, theologian, and exegete Benito Pereira (1535–1610). He did not only follow Piccolomini's opinion, but radicalized it. In his treatise *De Communibus omnium rerum naturalium principiis et Affectionibus, libri quindecim* (On the common principles and states of the natural things in fifteen books), first printed in 1576, Pereira made no secret of his assessment and opened his contribution to the

153. Gorman, "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670", p. 22.

154. For a more specific account of the *Quaestio* and its evaluation in light of the course of the Scientific Revolution, see Tobias Schöttler, "From Causes to Relations: The Emergence of a Non-Aristotelian Concept of Geometrical Proof out of the Quaestio de Certitudine Mathematicarum", *Society and Politics* 6, no. 2 (12) (2012): pp. 29–32; further literature on the topic can also be found in Luís Miguel Carolino, "Cristoforo Borri and the epistemological status of mathematics in seventeenth-century Portugal", *Historia Mathematica* 34, no. 2 (2007): p. 191.

155. See page 20.

156. Schöttler, "From Causes to Relations", p. 31.

157. Daniele Cozzoli, "Alessandro Piccolomini and the certitude of mathematics", *History and Philosophy of Logic* 28, no. 2 (2007): pp. 151–171. It should be pointed out that, while denying geometry the status of an Aristotelian science, Piccolomini did not attack its usefulness or validity.

158. For further reactions, see Schöttler, "From Causes to Relations", p. 35; R. W. Serjeantson, "Proof and Persuasion", in *The Cambridge History of Science*, ed. Katherine Park and Lorraine Daston, vol. 3 (Cambridge: Cambridge University Press, 2006), p. 155; Volker Remmert, *Ariadnefäden im Wissenschaftslabyrinth* (Bern: Peter Lang, 1998), pp. 86–88.

debate with the words, "in my opinion, the mathematical disciplines are not proper sciences".[159]

The effect of Pereira's position is not to be underestimated. Having written the "most authoritative commentary on *Genesis* of the day",[160] his word carried a lot of weight both within and beyond the Jesuits, and he became one of the primary sources with regards to the *Quaestio*. The above mentioned Isaac Barrow, for instance, drew from the Jesuit theologian for his own deliberations speaking out in favor of mathematics, using him as a reference for the main points that were brought up against it.[161] In search of other positive arguments, Barrow repeatedly called upon Christoph Clavius,[162] and it was Clavius who became Pereira's main antagonist in the discussion about the certainty of mathematics as well as the first and main Jesuit apologist of the mathematical sciences. With the subordinate role that had been assigned to mathematics in the *Constitutiones*, he had a greater task than just arguing against the criticism initiated by Piccolomini; in fact, Clavius had to prove that mathematics was useful for the Society in the first place, that it helped, just as Loyola had envisioned, to prepare the minds of students for the higher studies of theology, that it contributed in furthering the Jesuit goals, and that it was, in summary, "fundamental to achieving the aims underlying the Company's pedagogic objectives".[163] These two essentially separate issues—one concerning the status of mathematics as an Aristotelian science, the other the usefulness of mathematics for the Society of Jesus—hence often turned into two sides of one and the same coin.

A good example of this can be found in the 1582 document *Modus quo disciplinae mathematicae in scholis Societatis possent promoveri* (The way in which the mathematical disciplines could be promoted in the schools of the Society). Here, Clavius addresses a very particular Jesuit problem and complains: "teachers of philosophy teach that the mathematical sciences are not sciences, that they do not have proper proofs, that they prevent from the whole and good",[164] thus effectively deterring their students from

159. "Mea opinio est, Mathematicas disciplinas non esse proprie scientias", Benito Pereira, *De Communibus omnium rerum naturalium principiis et Affectionibus, libri quindecim* (1579), p. 40. Marco Lamanna, "Mathematics, Abstraction and Ontology: Benet Perera and the Impossibility of a Neutral Science of Reality", *Quaestio*, no. 14 (2014): pp. 69–89, gives a thorough discussion of this work.

160. Ernan McMullin, "Galileo on science and Scripture", in *The Cambridge Companion to Galileo*, ed. Peter Machamer (Cambridge: Cambridge University Press, 1998), p. 288.

161. Isaac Barrow, *The usefulness of mathematical learning explained and demonstrated* (London, 1734), pp. 80 and 97.

162. Aside from referring to Clavius' edition of Euclid in his arguments, such as within Lecture XVI "Of the Homogeneity and Heterogeneity of Quantities", he also refers to the man himself and calls him "excellent" (p. 228) and "sagacious" (p. 298). Ibid.

163. Gatto, "Christoph Clavius' 'Ordo Servandus'", p. 239.

164. "[P]raeceptores philosophiae docent scientias mathematicas non esse scientias, non habere demonstrationes, abstrahere ab ente et bono", Christoph Clavius, "Modus quo disciplinae mathematicae in scholis

learning mathematics by badmouthing it.[165]

The Jesuit philosophers' dismissive stance was not only based on the controversial *Quaestio*, however, as much as it did offer them a welcome point of attack. Another issue at play was given by a certain rivalry that existed between the natural philosophers of the order and its mathematicians. With the invention of new instruments and a radical increase of knowledge about the world, the latter applied their trade to offer explanations in a realm that had previously belonged exclusively to the former, resulting in a strained relationship.[166]

As for an explicit contribution by Clavius to the discussion on the certainty of mathematics, he addressed the criticism of mathematical proofs not being of proper form in his edition of Euclid—appropriately enough by reformulating Proposition I.1 to match the required Aristotelian scheme. His conclusion then contains the following rather cheeky comment:

> "Not in any other way can not only all the other propositions of Euclid, but also of all the other mathematicians be resolved. Mathematicians, however, disregard such resolutions in their proofs, because they can show what they propose in a shorter and easier way without them."[167]

Aside from notes like this, Clavius seems to have rarely taken an explicit stance in writing. Nonetheless, "his dedicated campaign for a revaluation of mathematics in the Jesuit curriculum, without which the rich bloom of Jesuit mathematics is hard to imagine, certainly has to be understood within the context of the *Quaestio*,"[168] as Volker Remmert summarizes.

Societatis possent promoveri", in *Monumenta Paedagogica Societatis Jesu Quae primam Ratiomem Studiorum anno 1586 editam praecessere*, ed. Caecilius Gomez Rodeles et al. (Madrid: Institutum Historicum Societatis Iesu, 1901 [1582]), p. 473.

165. A closer study of the efforts made by Clavius and his disciples in order to promote and secure the mathematical sciences within the order can be found in Chapter 2, "Trusting the Jesuit *mathematicus*", in Gorman, "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670", pp. 47–75 (pp. 44–70 in the table of contents). Note: Since there is no printed edition of this work at the time of writing, I contacted the author directly who was so kind to send me a PDF of his thesis. However, the formatting of this PDF is not final; in particular, the page numbering in the table of contents does not correspond with the actual page numbering.

166. See also Volker Remmert, "Im Zeichen des Konsenses. Bibelexegese und mathematische Wissenschaften in der Gesellschaft Jesu um 1600", *Zeitschrift für Historische Forschung* 33, no. 1 (2006): pp. 44–49.

167. "*Non aliter resolui poterunt omnes aliae propositiones non solum Euclidis, verum etiam caeterorum Mathematicorum. Negligunt tamen Mathematici resolutionem istam in suis demonstrationibus, eo quod breuius ac facilius sine ea demonstrent id, quod proponitur*", Christoph Clavius, *Euclidis Elementorum libri XV* (1574), Liber I., pp. 22r–22v.

168. "Seine engagierte Kampagne zur Aufwertung der Mathematik im jesuitischen Studienplan, ohne die die prächtige Blüte der Jesuitenmathematik kaum vorzustellen ist, ist zweifellos im Zusammenhang mit der *Quaestio* zu lesen." Remmert, *Ariadnefäden im Wissenschaftslabyrinth*, pp. 86–87. As evidenced by the

Mathematics in the Jesuit study plan

The curriculum spoken of here is the famous *Ratio atque Institutio Studiorum Societatis Iesu* (The plan and method of studies in the Society of Jesus) of 1599, for short *Ratio Studiorum* or just *Ratio*. As I have pointed out during the discussion of the Jesuit Constitutions, Ignatius of Loyola stipulated in them that a universal study plan should be devised once the Society had collected enough experience with the realities of teaching. In the time following, several documents and decrees emerged that dealt with theoretical and/or practical aspects of Jesuit education,[169] Nadal's and Torres' efforts counting among the first of them. As much as these documents helped in the overall development and preparation of a general curriculum, doing so was usually not their primary concern. This led to the problem that while guidelines did exist, they were often only meant for particular colleges, such as Nadal's Messina curriculum, or drafted for particular courses, such as Torres' plan for the mathematical instruction at the *Collegium Romanum*. This diversity made it furthermore impossible to observe the Society's ideal of *unitas et uniformitas doctrinae*.

In 1564, a first attempt to set up a universal study plan based on the knowledge gathered at the Jesuit college in Rome was begun. The work dragged on; between reviews and revisions, a first part on *literae humaniores* was sent out to the Jesuit provinces at the end of 1569 and another on scholastic philosophy followed in 1571, but the one dealing with theology remained a bone of contention even beyond that.[170] In addition to the long development, the plans seem to have lacked in detail, failing to provide the expected how-to for Jesuit education; this point of critique, however, still held for the definite study plan of 1599, as well.[171]

During the Fourth General Congregation of the Society of Jesus in 1581, the delegated Jesuits pressed for a remedy of the situation. A special commission was created to ultimately put a universal curriculum into writing, and after it failed to come to any results, a second commission was appointed in 1583. This, finally, was successful.[172] In April 1586, the very first draft of the *Ratio Studiorum* was sent out to the Jesuit provinces for commenting. Two more versions were drafted—one later in the same year, although it was not released, the other one in 1591—before the final edition of the *Ratio* was

examples in Udías, *Jesuit Contribution to Science*, pp. 13–14, this campaign was also taken up and continued by Clavius' students.

169. Lukács, "A History of the Ratio Studiorum", pp. 18–26.
170. Ibid., pp. 23–26.
171. Ibid., p. 24.
172. For a brief description of the work done by the commission, see ibid., pp. 29–31.

eventually published in 1599.[173]

Interestingly enough, Christoph Clavius was not directly involved with the creation of the *Ratio*, although he attempted to contribute indirectly through commentaries on the reputation of mathematics in the Society and instructions for its promotion as part of his campaign.[174] In this context, three texts of his are to be named: *Ordo servandus in addiscendis disciplinis mathematicis* (The order which must be preserved in learning the mathematical sciences) of 1581, *Modus quo disciplinae mathematicae in scholis Societatis possint promoveri* (How the mathematical disciplines can be furthered in the schools of the Society) of 1582, and *De re mathematica instructio* (On the instruction of mathematics) from before 1593. All three treatises concern his ideas on mathematical education for and by Jesuits, ranging from giving advice on how to choose an appropriate teacher, over admonishing a change in the so far negative mindset towards mathematics within the Society in the first place, up to proposing a mathematics curriculum complete with course arrangements and suggested literature.[175] The latter two of these documents then found their way into the 1586 and 1591 drafts of the *Ratio Studiorum*;[176] at least the first was probably assigned reading for the commission working on the curriculum.[177]

Before I continue to present some differences between the drafts of the *Ratio*, I would first like to take a look at its final version. While scrutinizing the parts that concern the teaching and study of the mathematical and natural sciences, I found a passage that is almost identical to an earlier quote from the *Constitutiones*:[178]

> "Since the arts and the natural sciences dispose the intellectual talents for theology and assist them in arriving at perfect knowledge and its use, and since even by themselves they help these talents towards the same final goal, the teacher should, with due diligence, honestly seeking the honor and glory of God in all things, treat them in such a way that he prepares his own students and especially Jesuits for theology and most of all rouses their desire to know their Creator."[179]

173. Lukács, "A History of the Ratio Studiorum", pp. 31–44. On the revisions made between the different versions, see also pp. 44–45. A timeline of the events is given in Claude Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education* (Saint Louis: The Institute of Jesuit Sources, 2005), pp. 217–219.
174. See footnote 168 on page 51.
175. More on these texts can be found, for example, in Gatto, "Christoph Clavius' 'Ordo Servandus'", and Engelfriet, *Euclid in China*, pp. 32–35.
176. Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities", pp. 450–451.
177. Ibid., pp. 450.
178. See page 44.
179. "*Quoniam artes vel scientiae naturales ingenia disponunt ad theologiam, et ad perfectam cognitionem et usum illius inserviunt, et per se ipsas ad eundem finem iuvant, eas, qua diligentia par est, praeceptor, in omnibus sincere*

The *Ratio Studiorum* hence picks up and continues in Loyola's spirit from almost half a century earlier; the natural sciences are subordinate to theology, their application is mostly preparatory, and it is ultimately left to the particular teacher's discretion up to which extent he choses to treat them at all. However, in contrast to the *Constitutiones*, the *Ratio* does offer rules in order to help with this choice.

The Jesuit study plan begins with the declaration that "one of the leading ministries of our Society is teaching our neighbors [...] in such a way that they are thereby aroused to a knowledge and love of our Maker and Redeemer"[180], thus firmly anchoring teaching at the very core of the order. Then, a general organization of the classes is given—duration and extent, admission of students, education of future teachers, holidays, etc. – and further administrative tasks for the rector of a Jesuit school are defined. The main part then presents the subjects to be taught by directly addressing their teachers, giving them further details concerning form and content, and in the end, some rules for the prospective students are established, mostly touching on proper behavior.

Of all these rules, the *Regulae Professoris Mathematicae* (Rules for the teacher of mathematics) are of course especially interesting.[181] In order to evaluate them, it now proves useful to take a closer look at their implementation in both the final and the earlier versions of the curriculum, based on the detailed study presented by Dennis Smolarski.[182] This allows for the following summary of the contents:[183]

1586 published draft Appointment of two mathematics professors at the Collegium Romanum ("naming Clavius as a possibility for one of these positions"[184]), compulsory studies of mathematics during at least one and a half years for all students, three year advanced course for eight to ten students.

1586 unpublished draft Public presentations of mathematical problems once or twice per month, reduction of the advanced course to four to five students.

1591 draft Reduction of the compulsory studies of mathematics for all students to one year (although a second year is recommended for students of metaphysics), further reduction of the advanced course to only six months.

honorem et gloriam Dei quaerendo, ita tractet, ut auditores suos, ac potissimum nostros, ad theologiam praeparet, maximeque ad cognitionem excitet sui Creatoris." Both original and translated text from Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education*, p. 99.

180. Ibid., p. 7.

181. Ibid., pp. 109–110.

182. Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities".

183. Ibid., pp. 451–453.

184. Ibid., p. 451.

1599 final version Duration of studies of mathematics no longer specified, no mention of compulsory studies for all or an advanced course, timetable and contents addressed at students of physics,[185] public presentation of mathematical problems only once per month or once every two months.

There is something particularly interesting to note about the lack of compulsory studies and advanced courses in the published *Ratio*, namely its position in the text. The paragraph stating that only students of philosophy should regularly attend a mathematics class in their second year and that those who are gifted in this subject should continue to study on their own in their private time, as there would be no higher classes, is entirely separated from the actual rules.[186] It can be found close to the beginning of the document, preceded by instructions on how to determine a student's general talent for learning and succeeded by suggestions on the composition of classes. As such, it looks rather out of place, both in regards to the rules for mathematics and philosophy, and leaves room for speculation about the reasoning behind its placing.

The demand of two mathematics professors at the Roman College, still included in the very first draft, was part of a "lengthy *apologia* about mathematics and its connection to various disciplines and professions"[187] that Clavius had written. This apologetic introduction was shortened for the second, unpublished draft of 1586, and removed completely afterwards. It should be pointed out, however, that no other discipline received any kind of vindication in the *Ratio*, either.[188]

Concerning the topics that should be covered in a Jesuit mathematics class, the *Ratio Studiorum* names Euclidean geometry, Sacrobosco's Sphere—both certainly following the commentaries that Clavius wrote—or something else pertaining geography, and then, without giving any further details, "those things that are usually of interest".[189] On one hand, this lack of direction speaks again for a poor appreciation of mathematics; on the other, it very much allowed the mathematics teacher to design his own curriculum.

Little is also said about the natural sciences. Aristotle is once more made the highest philosophical authority, but under conditions imposed by religious doctrine; no original text and no commentator should be treated if they contradict the Christian faith,[190] a

185. The chapter begins with the words "Physicae auditoribus". Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education*, p. 109.
186. Ibid., pp. 19–20. The rules themselves are on pp. 109–110.
187. Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities", p. 451.
188. Ibid., p. 452.
189. Ibid., p. 109.
190. Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education*, pp. 99–100.

statement that had not yet been made so explicitly in the *Constitutiones*. The passage on Aristotle continues to specify which of his books are to be studied and to what extent, particularly devoting the second year of education to his Physics. With regards to his book on the Heavens, only certain parts should be taught, while "the rest should be left to the professor of mathematics or gathered into an abridgment".[191] The mathematics teacher is hence supposed to pick up the pieces left over in another course instead of teaching his actual subject.

Smolarski also makes observations about the length of the mathematical instructions in the different *Ratio* drafts and remarks upon the apparently drastic change in quantity. Between the first and the final version, the amount of text that deals with mathematics has been reduced by about a quarter.[192] However, this observation would need to be part of a general comparative study in order to be truly meaningful, recording the changes in text quantity for several subject matters between the first and final versions of the curriculum. Such a study could be realized with the help of digital methods. After acquiring OCRed scans of all the versions of the *Ratio Studiorum* to enable a computer-aided analysis, one could identify and compare the respective passages either 'by hand' or by making use of suitable text analysis applications.[193] As an exercise in Digital History, the study could also compare several applications in terms of ease of use, requirements to the text, and modes of evaluation. A manual analysis could be used as a sort of baseline in comparison to which the software could be examined.

Summary

As I have shown, Ignatius of Loyola injected little appreciation for the mathematical sciences in the *Constitutiones Societatis Iesu* of 1558. Forty-one years later, the authors of the *Ratio Studiorum* continued in the same sentiment in terms of content, placing, and wording, confirming the auxiliary function of the natural sciences and treating mathematics nearly as an afterthought.

But even so, just being a part of the *Ratio* established it as a fixed aspect of Jesuit education, thus creating a "normative constraint to teach mathematics and engage in

191. Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education*, pp. 102–103.
192. Smolarski, "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities", p. 452. The remaining text does not even take up an entire page in total and thus constitutes the shortest entry for any discipline along with the only slightly longer entry for moral philosophy. For this compare Pavur, *The Ratio Studiorum : The Official Plan for Jesuit Education*, pp. 108–109.
193. Such applications can be found in the DiRT (Digital Research Tools) Directory, a curated collection of digital research tools for scholarly use, see `http://dirtdirectory.org/`. The directory contains links to both closed and open software.

it in the first place".[194] In hindsight, the lack of details actually turned out to be very beneficial. Since the 1599 document was not revised until the nineteenth century and a successor came out only in 1986,[195] any elaborate mathematical curriculum given by the *Ratio* would have been based on the state of affairs in the second half of the sixteenth century, and thus become outdated very quickly.[196]

What is more, the implementation of the universal Jesuit study plan relied on local circumstances such as the availability of mathematically trained teachers or specific regional demands in terms of content, anyway.[197] Because of that, a plethora of case studies on Jesuit mathematical practices focus on specific geographical areas—for example a Jesuit province or a particular college—for which they discuss local curricula, portray the available teachers, shed light on mathematical patronage, or trace the relationships that the Jesuit mathematicians maintained amongst themselves as well as with scholars outside of the Society.[198]

On the subject of patronage in particular, Martha Baldwin assesses with regards to the seventeenth century that "Jesuit provincials and rectors were careful to seize every opportunity to engage the favorable attention of Catholic nobles by the solicitation of patronage, for they were acutely aware that Jesuit books of mathematics and natural

194. "Damit bestand der normative Zwang, Mathematik zu lehren und sich damit mit ihr überhaupt zu beschäftigen" Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*, p. 46.

195. For further information on the development of the modern version of the *Ratio Studiorum*, a document succinctly called *Characteristics of Jesuit Education*, see Vincent J. Duminuco, "A New *Ratio* for a New Millennium?", in *The Jesuit Ratio Studiorum : 400th Anniversary Perspectives*, ed. Vincent J. Duminuco (New York: Fordham University Press, 2000), pp. 145–160.

196. Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*, p. 46.

197. Portugal, for instance, was in particular need of nautical expertise as a seafaring nation, and so appropriate courses were developed and taught at Portuguese Jesuit colleges. See Luís Miguel Carolino and Henrique Leitão, "Natural Philosophy and Mathematics in Portuguese Universitites, 1550–1650", in *Universities and Science in the Early Modern Period*, ed. Mordechai Feingold and Victor Navarro-Brotóns (Dordrecht: Springer, 2006), pp. 159–164; Henrique Leitão, "Jesuit Mathematical Practice in Portugal, 1540-1759", in *The New Science and Jesuit Science : Seventeenth Century Perspectives*, ed. Mordechai Feingold, vol. 12, Archimedes (Dordrecht: Kluwer Academic Publishers, 2003), pp. 237–238.

198. To name but a few examples concerning the Catholic Netherlands, Clermont, the Polish-Lithuanian Commonwealth, Spain, Prague, and Mainz: Angelo de Bruycker, "'To the adornment and honour of the city': the mathematics course of the Flemish Jesuits in the seventeenth century", *BSHM Bulletin* 24, no. 3 (2009): pp. 135–146; Antonella Romano, "Teaching Mathematics in Jesuit Schools: Programs, Course Content, and Classroom Practices", in *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, ed. John O'Malley (Toronto: University of Toronto Press, 2006), pp. 355–370; Bogdan Lisiak, *Nauczanie matematyki w polskich szkołach jezuickich od XVI do XVIII wieku* (Kraków: Wydawnictwo NAM, 2003); Víctor Navarro, "Tradition and Scientific Change in Early Modern spain: The Role of the Jesuits", in *Jesuit Science and the Republic of Letters*, ed. Mordechai Feingold (Cambridge: The MIT Press, 2003), pp. 331–388; Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740*; Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*; Albert Krayer, *Mathematik im Studienplan der Jesuiten*, Beiträge zur Geschichte der Universität Mainz (Stuttgart: Franz Steiner Verlag, 1991).

philosophy enhanced the reputation of the Society in general";[199] sufficient knowledge of the sciences was even recognized as helpful for Jesuit missionaries "not only to perform certain tasks but also to attach credit to their religious teaching".[200] Musical instruments, for instance, and written instructions on how to build them were quite liked in China, and were hence used by the Society to attract those willing to convert.[201]

In summary, there is a striking discrepancy between the theoretical placement and valuation of mathematics in both the *Constitutiones* and the *Ratio Studiorum*, and the factual mathematical engagement by Jesuit scholars. Early indicators for this mismatch can be found even before the *Ratio* when Jerónimo Nadal and Baltasar de Torres, who set up or influenced the first curricula within the Society of Jesus, ultimately failed in their attempts at codifying a universal mathematical instruction. A similar situation occurred with Christoph Clavius. His campaign for the defense and promotion of the mathematical sciences had little effect on the final *Ratio*, and yet, the many editions of the *Euclidis elementorum libri XV* and other of his works show the demand that existed for such textbooks,[202] a demand that was accompanied by great esteem towards the books, their author, and eventually also the religious order to which he belonged. Clavius' accomplishments were an advertisement for the quality of Jesuit education and the high level of Jesuit intellectual prowess, manifestations of the Society's self-image as an intellectual elite.

However, a proper investigation into this discrepancy and especially the reasons behind it would warrant a larger discussion than is possible within the scope of this thesis.[203] Although I hence only touched on the topic of the valuation of mathematics within the Society, it suffices to clarify that a mere study of the Jesuit foundational documents is not enough. In order to be able to adequately describe the status of mathematics—or, more general, also the status of the sciences, it is necessary to study the involved activities as performed by the involved Jesuit scholars, which is exactly what the Jesuit Science Network is designed to do.

199. Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century", p. 291.
200. Baldini, "The Academy of Mathematics of the Collegio Romano from 1553 to 1612", p. 54.
201. John Edward Fletcher, *A Study of the Life and Works of Athanasius Kircher, "Germanus Incredibilis"*, ed. Elizabeth Fletcher (Brill, 2011), p. 103.
202. Baldwin, "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century", p. 289.
203. First insight into possible causes are offered by Georg Schuppener in his study on the mathematical practices at the Jesuit college in Prague. Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*, pp. 45–48.

2.3. Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus*

In this subsection, I would like to put the focus on the source material for the Jesuit Science Network, the *Bibliothèque de la Compagnie de Jésus* by French Jesuit Carlos Sommervogel (1834–1902).[204] Published in twelve volumes between 1890 and 1932 with a reprint in 1960, this bio-bibliographical encyclopedia on the members of the Society of Jesus is and remains one of the standard works among researchers of Jesuit history. Its age notwithstanding, it is still the most extensive such collection until now, spanning the period from the very beginning of the order up until its publication.

2.3.1. Terminology

For reasons of convenience, I will henceforth refer to the *Bibliothèque de la Compagnie de Jésus* also by its abbreviated title *Bibliothèque*, as the Sommervogel series (meaning 'series of books', not 'book series'), or just Sommervogel. Speaking of terminology, my labeling the *Bibliothèque* as source material in the beginning is somewhat problematic and requires further explanation. From the point of view of the historical sciences, the term 'source' is reserved for artifacts (e.g., documents, manuscripts, diaries) that were created at the time under investigation, while (usually written) accounts providing an analysis, synopsis, or interpretation of or based on such sources are referred to as 'literature'. Given this understanding, the Jesuit *Ratio Studiorum* constitutes a source while the *Bibliothèque* counts as literature. From the point of view of computer science, however, 'source' is equal with 'data source' in this context, and describes any kind of artifact that provides the information to be collected, in the case of the JSN biographical data. Following this definition, Sommervogel is no different from the records that early modern Jesuit colleges kept on the numbers of their superiors, teachers, and students.[205]

Although both concepts use the word 'source', they do not necessarily contain the same meaning; it should be noted that the distinction made concerns the function that the described artifact fulfills for its user, not so much its user-independent form. This is an example of a fundamental issue with interdisciplinary work where the respective vocabulary might look very similar, but denote inherently different things. This

204. He was actually christened Marie-Nicolas-Charles and later changed his name. Robert Danieluk, *La Bibliothèque de Carlos Sommervogel: Le sommet de l'œvre bibliographique de la Compagnie de Jésus (1890–1932)* (Institutum Historicum Societatis Iesu, 2006), p. 27.

205. For example, Baldini, "The Academy of Mathematics of the Collegio Romano from 1553 to 1612", provides a list of the mathematicians recorded in the catalogs of the *Collegium Romanum*, pp. 71–74.

can potentially led to misunderstandings not just among interdisciplinary researchers themselves, but also among readers and users of the project, leaving them with the bad and incorrect impression that the work done does not conform to the standards of their respective community. It is hence necessary to address issues of terminology as soon as they come up and remain aware of the fact that interdisciplinary work involves not just an interdisciplinary subject, but also interdisciplinary methods and, most of all, language. What is more, overlaps can be quite difficult to anticipate as each side is naturally immersed in their own vocabulary.

That said, aside from the historical discussion of the *Bibliothèque* in the current section, where it is appropriately treated as literature, Sommervogel and any other artifact providing biographical information for the JSN are considered (data) sources for the remainder of the thesis, see also Section 3.2 in the next chapter on the Jesuit Science Network itself.

2.3.2. The Jesuit bibliographical tradition

But for now, I shall return to Carlos Sommervogel and his work. Judging by the use and esteem that the *Bibliothèque* enjoys among researchers of Jesuit history, surprisingly little has been written about the series and its editor. As far as I am aware, the only comprehensive study in that regard was published in 2006 by Robert Danieluk,[206] and a short English summary of this French monograph is given in the paper accompanying the publication of 'The Boston College Jesuit Bibliography: The New Sommervogel Online', an online database cataloging all things Jesuit,[207] but so far, that seems to be all.

In naming it after Sommervogel, the editors of the New Sommervogel Online attempt to establish their project as a link in the long Jesuit bibliographical tradition, the foundations for which were laid by Ignatius of Loyola and his co-founders themselves. They dictated for the their order to maintain frequent written administrative correspondence and generally to keep track of its accomplishments, hence ensuring the existence and preservation of source material in general.[208]

206. Danieluk, *La Bibliothèque de Carlos Sommervogel: Le sommet de l'œvre bibliographique de la Compagnie de Jésus (1890–1932)*.

207. This means "Jesuit-themed books, book chapters, articles, and book reviews". Kasper Volk and Chris Staysniak, "Bringing Jesuit Bibliography into the Twenty-First Century: Boston College's New Sommervogel Online", *Journal of Jesuit Studies* 3, no. 1 (2016): p. 61. As is stated on the following page of the article, the New Sommervogel Online currently only offers material published after 2011 but is eventually supposed to cover the entire existence of the Society of Jesus.

208. John O'Malley, "The Historiography of the Society of Jesus: Where Does It Stand Today?", in *The Jesuits : Cultures, Sciences, and the Arts, 1540–1773*, ed. John O'Malley et al. (Toronto: University of Toronto Press, 1999), p. 4.

The first Jesuit publication working towards a bibliography of the order appeared already in 1608, extended successors followed in 1643 and 1676.[209] While further efforts in the eighteenth century did not come to a conclusion,[210] some (now ex-)Jesuits continued to collect bibliographical information also during the period of suppression. Most of these collections only found their way into archives, but a few did reach publication.[211]

After the restoration of the Society in 1814, the 21st General Congregation of 1829 decided to restore the order also by continuing its bibliographical tradition. The provincials were tasked to collect material from the Jesuit installments under their supervision and forward it to Rome. For that purpose, they were given instructions on what information was to be gathered and how it was to be structured;[212] unfortunately, many of the records accumulated that way were lost during the Italian revolutions of 1848, but the accomplished work still allowed for the publication of several partial bibliographies, for instance in the Austrian and Polish provinces.[213]

Eventually, the Belgian Jesuit Augustin De Backer (1809–1873) was entrusted to prepare a Jesuit bibliography and helped by his brother Aloïs De Backer (1823–1883), also a member of the Society. The result of their work was the *Bibliothèque des écrivains de la Compagnie de Jésus, ou notices bibliographiques: 1. de tous les ouvrages publiés par les membres de la compagnie de Jésus depuis la fondation de l'ordre jusqu'à nos jours; 2. des apologies, des controverses religieuses, des critiques littéraires et scientifiques suscitées à leur sujet, par Augustin et Aloïs De Backer de la même Compagnie* (Library of the writers of the Society of Jesus, or bibliographical notes: 1. of all works published by members of the Society since the foundation of the order until our days; 2. the apologias, the religious controversies, the literary and scientific critiques evoked by their subject, by Augustin and Aloïs De Backer of the same Society), published in seven volumes between 1853 and 1861.[214] Each of the volumes is sorted in itself alphabetically by last name, but lists the authors contained overall in a register along with a reference to the respective volume. In contrast to the earlier Jesuit bibliographies, the De Backers decided to give work titles in their original languages instead of translating them into Latin, and similarly wrote the descriptive texts in French. They also shortened the biographical descriptions in favor of extending

209. Danieluk, *La Bibliothèque de Carlos Sommervogel: Le sommet de l'œvre bibliographique de la Compagnie de Jésus (1890–1932)*, pp. 61–91.
210. Ibid., pp. 91-100.
211. There is, for example, a published bibliography on works written by a group of Jesuits from Tarragona, Spain, who were deported to Italy; see ibid., p. 102. An overall description of the bibliographic tradition during the suppression can be found on pp. 100–106.
212. Ibid., pp. 112–113.
213. Ibid., pp. 114–117.
214. Ibid., pp. 124–129.

the bibliographical information.[215]

In the first volume of the *Bibliothèque des écrivains*, the brothers had asked their readers to send in corrections and additional information, intending to publish the data later in an eighth, supplemental volume. When the fourth volume had just appeared in 1856, a young Carlos Sommervogel began to take notes of such mistakes. He amassed a considerable amount in the next four years before he finally got in touch with the two editors,[216] and the material was so plenty that the De Backers scrapped the idea of a supplement in favor of a second edition of the entire bibliography. They came to accept Sommervogel as a valuable collaborator[217] and acknowledged his contribution by including his name in the title of the revised and improved edition, published in three volumes between 1869 and 1876.[218] It was not well received, however, if only because there were only 200 copies made in total; what is more, the paper used for printing was of poor quality and the chosen layout hampered the readability.[219]

A different point of critique regarding the *Bibliothèque des écrivains*—and, in fact, all of the Jesuit bibliographies so far—was that they only collected works written by Jesuits, but not works written about Jesuits. Auguste Carayon (1813–1874), French confrère to the De Backers and Sommervogel, felt it necessary to have bibliographies on the history of not only the Society of Jesus, but all religious orders in general. As would seem natural for a Jesuit, he applied himself to such a work on the history of his own order, and published the *Bibliographie historique de la Compagnie de Jésus ou catalogue de ouvrages relatifs à l'histoire des jésuites depuis leur origine jusqu'à nos jours par le P. Auguste Carayon de la même Compagnie* (Historical bibliography of the Society of Jesus or catalog of works related to the history of the Jesuits since their beginning until our days by P. Auguste Carayon of the same Society) in 1864. In his years of research, Carayon had exchanged letters with both the De Backers and Sommervogel, whom he asked for help occasionally,[220] and saw the *Bibliographie historique* as complementary to the *Bibliothèque des écrivains*.[221]

215. Danieluk, *La Bibliothèque de Carlos Sommervogel: Le sommet de l'œvre bibliographique de la Compagnie de Jésus (1890–1932)*, pp. 124–125.
216. Ibid., pp. 28–29.
217. On the notes submitted by Sommervogel and the De Backer's reaction to them, see ibid., pp. 26, 28–29, 32, and 130, for instance.
218. Ibid., pp. 131–133.
219. Ibid., p. 132.
220. See, for example, ibid., pp. 136–137.
221. Carayon's work is discussed in more detail in ibid., pp. 134–139.

2.3.3. The *Bibliothèque de la Compagnie de Jésus*

With the *Bibliothèque des écrivains* still lacking in terms of corrections and additional information, and the second edition being "practically inaccessible",[222] it was apparent that the work begun by Augustin and Aloïs De Backer was in need of a third edition. Both Aloïs De Backer and Carlos Sommervogel were aware of that as early as 1877[223]—Augustin De Backer had died in 1873—but due to internal quarrels over responsibility, it took until 1885, two years after Aloïs' death in turn, until Sommervogel was finally put in charge of a third release.[224]

Based on the *Bibliothèque des écrivains* as well as the *Bibliographie historique*, Sommervogel intended to continue and expand in the spirit of both the De Backers and Carayon. He envisioned the next edition in two parts, the first containing works written by Jesuits, the second containing works written about Jesuits.[225] To ensure quality and quantity of this project, Sommervogel reached out to the provincials of the order asking them for their records and corresponded with other editors of biographical and bibliographical works, many among them non-Jesuits;[226] in addition, confrères assisted him by researching libraries that he could not get to or correcting his spelling of foreign names. In 1890, his efforts finally resulted in the publication of the first of eventually twelve volumes of the *Bibliothèque de la Compagnie de Jésus*, albeit Sommervogel, who died in 1903, only lived to see the first nine volumes published. Table 2.1 on page 64 shows the dates of publication, the editors, and a brief description of the contents of the volumes.

The bibliographical part on Jesuit authors comprises volumes I through XI. The volumes are continuously sorted by last name. Parts of volumes VIII and XI contain the supplement; volume IX furthermore features a list of works written anonymously or under pseudonyms as well as a geographical index of authors sorted after their place of birth. Figure 2.2 on page 65 shows an exemplary page from the second volume. As can be seen here, Sommervogel adopted the style that the De Backers chose for the *Bibliothèque des écrivains*, so that the amount of biographical data—the running text following directly after the names—is often quite small in comparison to the amount of bibliographical data—the enumerated list of titles. The biographies are limited to places and dates of birth, entry into the order, and death, and some basic information about the education and further career, so far as these things were known. Both the biographical and the

222. "[P]ratiquement inaccessible" ibid., p. 143.
223. See the letter mentioned at the bottom of p. 142, ibid.
224. Ibid., pp. 144–149.
225. Ibid., pp. 139–140 and 176.
226. Ibid., pp. 150–159.

Vol.	Date	Editor	Contents
Bibliographical part			
I	1890	Carlos Sommervogel	Bibliography Abad-Boujard
II	1891		Bibliography Boulanger-Desideri
III	1892		Bibliography Desjaques-Gzowski
IV	1893		Bibliography Haakman-Lorette
V	1894		Bibliography Lorini-Ostrozanski
VI	1895		Bibliography Otazo-Rodriguez
VII	1896		Bibliography Roeder-Thonhauser
VIII	1898		Bibliography Thor-Zype, supplement Aage-Casaletti
IX	1900		Supplement Casalicchio-Zweisig, bibliography of works written anonymously or under pseudonyms, geographic index of authors arranged after their place of birth
Historical part			
X	1909	Pierre Bliard	Lists of titles from volumes I–IX arranged after subject (theology: Scripture, dogmatic theology, moral theology, catechism, parenetic theology, ascetic theology, polemic theology, liturgy; jurisprudence; sciences and arts: philosophy, sciences, fine arts; belles lettres: linguistics, eloquence, poetics, theater, philology, correspondence, polygraphy; geography and history: geography, chronology, universal history, secular history, church history) and topic (e.g., the New Testament)
XI	1932		Works written about the Society of Jesus
XII	1932	Ernest M. Rievière, Ferdinand Cavallera	Supplement for volumes I–IX in five fascicles

Table 2.1.: Contents of the Sommervogel volumes I through XII.

Les cinq premiers MSS. sont à la biblioth. de l'Université de Mexico ; le sixième, à la secrétairerie de la Métropole ; le septième, chez les PP. Augustins de Morelia.

Sotwel ; — Alcazar ; *Hist. de la Prov. de Toledo*, II, 82 ; — Oviedo : *Menologio*, p. 108 ; — Alegre : *Hist. de la C. de J. de la Nueva Espana*, I, p. 410 ; — Beristain ; — de Backer, II, 198-9.

HORVATH, Alexandre, né à Komorn, le 23 septembre 1723, admis le 17 octobre 1742, enseigna la grammaire et les humanités, fut appliqué à la prédication et résidait à Tyrnau en 1770.

A. Elegans historia in gymnasio Gincensi anno scholastico 1749 discipulis proposita. 4°. — A la bibl. des Bénédictins de Martinsberg, près Raab.

HORVATH, Gabriel, né à Raab, le 24 avril 1668, admis le 9 novembre 1687, enseigna la grammaire, les belles-lettres et la rhétorique et dirigea le séminaire de Koloswar en 1715. Il exerça ensuite le saint ministère dans différentes villes et mourut à Gran, le 14 juin 1740.

1. Egy mennyei hazánkba vezető magyar angyalka. Kassán, 1724.

2. * Lelki szem-gyogyito, avagy a szenteknek, á sz. képeknek, a szentek teteminek s ereklyéinek, és a Kristus sz. keresztének tiszteletében némelly-némelly vak nem-cátholikusoknak meg-világositására való könyvetske, melly-is deák nyelven... Kassán 1724-ben világosságra adattatván : egy, ugyan, azon társaság-bélitől magyarrá fordittatott Nagy-Bányán 1725-ben. Kassán, az emlittett Jesus társ. acad. bet. Frauenheim, Ján. Henr. által, 12°, pp. 49-201, slpelt. [Spirituale collyrium ad curandos nonnullorum acatholicorum oculos cæcitantes de Sanctorum et sacrarum imaginum necnon sanctorum corporum et sacrarum reliquiarum atque S. Crucis Christi cultu : olim sermone latino Cassoviæ anno 1724 editum, nunc a quodam ejusdem Societatis ungarico sermone adornatum.]

Traduit du P. Gabr. Szerdahelyi.

Katona, t. 38, p. 866 ; — Stöger ; — de Backer, II, 199. — III, 2257.

HORVATH, Jean-Baptiste, naquit le 13 juillet 1732, à Gran, d'après Caballero, mais, d'après d'autres biographes, à Güns. Il fut admis au noviciat de Trentschin, le 17 octobre 1751. Il fut préfet du collège de Tyrnau, et professeur de philosophie et de physique à Buda et à Tyrnau. En 1792, il fut nommé abbé de S^te^ Marie à Egra, et mourut à Pesth, le 20 octobre 1799.

1. Panegyricus Immaculatæ Virgini. Tyrnaviæ, 1760, 12°.

2. Panegyricus D. Ignatio. Tyrnaviæ, 1761, 12°.

3. Panegyricus D. Francisco Xaverio. Tyrnaviæ, 1762, 12°.

4. Institutiones Logicæ, quas in usum Discipulorum conscripsit Joan. Bapt. Horváth e Soc. Jesu, Philosophiæ Doctor, ejusdemque in Academia Budensi professor publicus ordinarius. Tyrnaviæ, Typis Collegii Academici Soc. Jesu. Anno MDCCLXVII, 8°, pp. 131, sllelt.— Anno MDCC.LXVIII, gr. 8°, pp. 131. — Institutiones Metaphysicæ quas..., pp. 392, 1 tabl.

Institutiones Logicæ, quas in usum Discipulorum conscripsit Joan. Bapt. Horvath e Soc. Jesu, Philosophiæ Doctor, ejusdemque in Academia Budensi professor publicus ordinarius. Editio secunda ab Authore recognita. Tyrnaviæ, Typis Collegii Academici Soc. Jesu, Anno MDCCLXXI, 8°, pp. 120-XXVI. — Institutiones Metaphysicæ. Edit. secunda ab Authore..., pp. 476, 1 tabl.

Institutiones logicæ, quas in usum auditorum Philosophiæ conscripsit Joan. Bapt. Horvath, e Soc. Jesu in Universitate Tyrnaviensi physicæ professor publicus et ordinarius. Augustæ Vindelicorum, Sumptibus Matthæi Rieger et filiorum, M.DCC.LXXII, 8°, pp. 128, slpelt. — Institutiones metaphysicæ. Editio novissima..., pp. 458.

Institutiones logicæ... Editio quarta ab auctore recognita. Agriæ, Typis scholæ episcopalis, 1773, 4°, pp. 134. — Institutiones metaphysicæ..., pp. 465, 1 tabl.

Institutiones... Horvath in Universitate... Editio novissima. Ibid., id., MDCCLXXIV, 8°, m. pag. — Editio VI. ab authore recognita. Typis Tyrnaviensibus, 1776, 8°, pp. 118 et 373. — Editio quarta emendatior. Augustæ Vindelicorum, sumptibus Matthæi Rieger p. m. Filiorum, MDCCLXXVIII, 8°, pp. 589, sll., 10 pl.

Institutiones logicæ et metaphysicæ. Augustæ Taurinorum, 1780, 8°, 2 vol.

Joan. Bapt. Horvath. Presbyteri Archidiœcesis Strigoniensis, nunc in Regia Scientiarum Universitate Budensi Theoriæ Physices sublimioris, Physices item experimentalis, et Mechanices Professoris publici ordinarii Institutiones Logicæ et Metaphysicæ in usum Auditorum Philosophiæ conscriptæ. Editio quinta ab Auctore recognita et aucta. Augustæ Vindelicorum, sumptibus Matthæi Rieger p. m. filiorum, MDCCLXXXI, 8°, pp. 420, slpelt., 1 pl.

Institutiones Logicæ, Auditorum usibus accommodatæ. Editio prima Veneta... — Institutiones Metaphysicæ, Auditorum usibus accommodatæ. Venetiis, excudebat Anton. Zatta, 1782, 8°, 2 vol., pp. 360, 1 tabl.

Institutiones logicæ... metaphysicæ. Budæ, 1782, 8°, pp. 118 et 362.

Joan. Bap. Horvath.... Institutiones Logicæ, et Metaphysicæ in usum auditorum philosophiæ conscriptæ. Editio sexta ab auctore recognita et aucta. Augustæ Vindelicorum, Sumptibus Matthæi Rieger p. m. Filiorum, 1788, 8°, pp. 420, slpelt.

L'éditeur dit dans sa préface que cette édition est la cinquième d'Augsbourg, précédée de six éditions de Tyrnau.

Institutiones logicæ... Budæ, Typis Reg. Universitatis, 1975, 8°, pp. 118 ; — Institutiones Meta-

Figure 2.2.: Exemplary page from Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus,* volume IV. Source: Göttingen Digitisation Centre (CC BY 4.0).

bibliographical parts are also interspersed with comments by the editor; an example can be found at the very bottom of the right column. These comments often indicate ambiguous or uncertain information or give additional context clues. Unfortunately, this does not save the *Bibliothèque* from being ambiguous or uncertain itself, but that is an issue for the later Section 3.2 on the data sources and their usage within the Jesuit Science Network.

The historical part of the *Bibliothèque* now consists of volumes X through XII. At least partially prepared by Sommervogel, these volumes remained in the care of fellow Jesuits and appeared after his death. To begin with, volumes X and XI were edited by Pierre Bliard (1852–1928). In volume X, he compiled the bibliographical entries from the first nine volumes into groups according to the five subjects theology, jurisprudence, sciences and arts, belles lettres, and geography and history; Table 2.1 also lists the respective subcategories of each subject group. It is not by chance that this grouping reads very similar to the one that Steven Harris uses in his PhD thesis and that I introduced on page 40; after all, it is based on Bliard's categorization. In Section 2.4.2, I will be taking a closer look at Harris' work.

It is finally the second last volume XI that contains the actual history of the Society of Jesus, i.e. a bibliography of works written about the order. The last volume XII is a bit of a special case as it is composed by five fascicles written between 1911 and 1930, the first four by Ernest Rivière (1854–1919) and the fifth by Ferdinand Cavallera (1875–1954). These fascicles provide a second supplement to the first nine volumes.

In its entirety, the *Bibliothèque de la Compagnie de Jésus* contains an estimated 157500 entries on 10400 pages.[227]

2.4. Outlining the contents of Jesuit science in the early modern period

In introducing the early modern sciences in Section 2.1, I have referred to the Cambridge History of Science for a modern tally of the associated subjects: natural philosophy, medicine, natural history, cosmography, alchemy and chemistry, magic, astrology, astronomy, acoustics and optics, theoretical and practical mechanics, and pure mathematics. Now that I have explained the concept of Jesuit science and introduced Carlos Sommer-

227. Theodore Besterman, ed., *A world bibliography of bibliographies and of bibliographical catalogues, calendars, abstracts, digests, indexes, and the like*, Fourth edition, second printing (Rowman / Littlefield, 1971), cols. 3261–3262; found after a reference in Volk and Staysniak, "Bringing Jesuit Bibliography into the Twenty-First Century: Boston College's New Sommervogel Online", p. 68.

vogel's bibliographic work, it is time to examine more specifically in which of these areas of knowledge the Jesuits engaged in during the early modern period. For this purpose, I will take on the point of view of a contemporary, the German Jesuit Gaspar Schott (1607–1666), and study the table of contents of one of his works, as well as rely on the already often mentioned modern evaluation of the *Bibliothèque de la Compagnie de Jésus* by Steven Harris.

2.4.1. Gaspar Schott's *Cursus mathematicus*

As I have discussed in Section 2.2.3, neither the Jesuit *Constitutiones* nor the Society's universal study plan, the *Ratio Studiorum*, gave particular details concerning the contents of mathematics instruction. As such, there is hardly any information about the theory, but there are sufficient sources on the practice: compendia and course books written by Jesuits for the use by (not only) Jesuit students. Gaspar Schott's *Cursus mathematicus* proves to be one of the most notable examples in this regard.

Schott, who taught mathematics and theology in Palermo and mathematics in Würzburg,[228] is especially known as the student and close collaborator of Jesuit polymath Athanasius Kircher (1602–1680). As such, he edited several of Kircher's works,[229] and mostly concerned himself with natural phenomena, 'magic', and experimentation in his own writings. His first publication, the 1657 *Mechanica hydraulico-pneumatica* (Hydraulic-pneumatic mechanics) on fountains and water gardens, notably includes a supplement with the first description of the experiments on the vacuum that Otto von Guericke (1602–1686) had conducted in Magdeburg in 1653–1654.

Of special interest for my work, however, is the already mentioned *Cursus mathematicus*, a book that, first published in 1661, received two more editions in 1674 and 1677. With the whole title reading *Cursus mathematicus, sive absoluta omnium mathematicarum disciplinarum encyclopaedia, In libros XXVIII digesta, Eoque Ordina disposita, ut quivis, vel mediocri praeditus ingenio, totam Mathesin a primis fundamentis proprio Marte addiscere possit* (Mathematical course or perfect encyclopedia of all mathematical disciplines, divided in 28 books, arranged in an order such that everyone, even if he is equipped with mediocre talent, can learn all of mathematics from the first foundations without help), the *Cursus mathematicus* is an encyclopedia and a teaching book on mathematics written explicitly

228. The biographical information on Schott's life is taken from T. F. Mulcrone, "Schott, Gaspar (Kaspar)", in *Diccionario Histórico de la Compañía de Jesús*, ed. Charles O'Neill et al., vol. IV (Madrid: Universidad Pontifica Comillas, 2001), cols. 3531–3532, and Sommervogel et al., *Bibliothèque de la Compagnie de Jésus*, vol. VII, cols. 904–912.

229. See the many mentions of Schott in Fletcher, *A Study of the Life and Works of Athanasius Kircher, "Germanus Incredibilis"*, for example pp. 22, 37 (conducting practical experiments), 45.

Figure 2.3.: Frontispiece to Gaspar Schott's *Cursus Mathematicus* (1677). Source: Munich DigitiZation Center (out of copyright, non-commercial re-use).

for beginners. Part of the rich imagery carried in the frontispiece, shown in Figure 2.3 on page 68, reveals the contents of the course.[230] In the lower half of the image, the mathematical sciences are depicted within or as a garden landscape, a motif often used not only by Schott.[231] In this scene, a bear and a lion—representing the constellations Ursa Major and Leo—are pulling a chariot carrying an armillary sphere, a model of the objects that can be seen in the sky; the wheels of the chariot consist of two globes showing terrestrial and celestial maps. On the tiled road behind the chariot, there are twelve mathematical drawings arranged in four rows and three columns. While the first three tiles just seem to be geometrical sketches, the remaining, taken top to bottom and left to right, depict ballistics, fortification, astronomy (heliocentric world system), statics, the art of sundials, practical geometry, algebra, geometry (Pythagorean theorem), and trigonometry,[232] all treated in the book. In the top half of the frontispiece, the crowned queen personification of mathematics, identifiable by the ruler and compass in her hand, presents Emperor Leopold I (1640–1705, reign 1658–1705), to whom Schott dedicated the *Cursus mathematicus*, with a copy of said book. While it was common that frontispieces showed authors offering their works to the dedicatee, this particular personification was intended to remind the reader that mathematics was the queen of all sciences,[233] a statement with a special emphasis in light of the discussions in Section 2.2.3.

Table 2.2 now lists the contents of the 28 books of Schott's work. In short, they encompass arithmetic, geometry, trigonometry, cosmography, theoretical and practical astronomy, astrology, chronography, geography, hydrography, horography, mechanics, statics, hydrostatics, hydraulic engineering, optics, catoptrics, dioptrics, military architecture, art of war, forts and formations, music, algebra, and logarithms. It might seem odd to see topics pertaining to the art of war featured on this list, after all, Schott was member of a religious order, but it was actually a rather common occurrence in Jesuit mathematical teaching especially during the seventeenth century.[234] As this period was

230. For a detailed description and interpretation, see especially Remmert, *Picturing the Scientific Revolution*, pp. 230–238.
231. A particularly prominent example can be found in the frontispieces to the editions of the *Apiaria universae philosophiae mathematicae* (The beehives of all mathematical philosophies), first published in 1642, by Schott's confrère Mario Bettini (1582–1657). See ibid., pp.214–228.
232. Eberhard Knobloch, "Kaspar Schott's 'encyclopedia of all mathmatical sciences'", *Poiesis Prax* 7 (2011): p. 229.
233. Remmert, *Picturing the Scientific Revolution*, p. 233.
234. Geert Vanpaemel, "Jesuit Mathematicians, Military Architecture and the Transmission of Technical Knowledge", in *The Jesuits of the Low Countries: Identity and Impact (1540–1773)*, ed. Rob Faesen and Leo Kenis (Leuven: Peeters, 2012), p. 110; see also Denis de Lucca, *Jesuits and Fortifications : The Contribution of the Jesuits to Military Architecture in the Baroque Age* (Leiden: Brill, 2012); Frédéric Métin, "Quand les jésuites enseignaient la fortification", *Bulletin APMEP* 439 (2002): pp. 223–234.

one of many military conflicts and wars, the demand for military expertise was huge,[235] and the Jesuits had to adapt to the requirements of their patrons. Future courtiers and officials, for instance, attended the classes at Jesuit colleges and necessarily had to posses enough knowledge about the art of war to be able to at least engage in learned conversation about it. While there are more detailed military treatises written by Jesuits,[236] Schott's presentation of these topics is quite superficial and oriented towards providing conversational information.

Going back to the Cambridge History of Science listing of the early modern sciences now reveals that Gaspar Schott's *Cursus mathematicus* covers more than one half of it. While cosmography, astrology, astronomy, optics, mechanics, and mathematics appear by name, at least parts of natural history (such as geography) and acoustics (as part of music) are also treated. In the next and last section dealing with the historical context, I will pick up the remaining subjects—natural philosophy, medicine, alchemy and chemistry, magic, and the rest of natural history and acoustics—as well.

2.4.2. Steven Harris' modern stocktaking

Over the course of this chapter, I have already referred multiple times to research by Steven Harris, but so far postponed a more detailed examination. In the following, I want to catch up on this and focus on two particular of his works, his 1988 PhD thesis and a later follow-up paper from 1997. Together, they make up one of the cornerstones of the concept behind the Jesuit Science Network and allow to conclude the description of Jesuit activity in the early modern sciences by providing a modern and extensive stocktaking of the contents of Jesuit science.

In the introduction to his PhD thesis, Harris sets his aim to recognize and link "particular patterns of [Jesuit] social and institutional structures to the distinctive features of Jesuit science".[237] Along with this goal, he formulates three guiding questions—How did science become something that was allowed and supported within the Society? What kind of science did the Jesuits engage in, and how? How did the 'being Jesuit' aspect influence the development of the scientific 'branch'?[238]—and sets out to answer

235. Vanpaemel, "Jesuit Science in the Spanish Netherlands", p. 111.
236. See, for example, the studies by Vanpaemel, "Jesuit Mathematicians, Military Architecture and the Transmission of Technical Knowledge", and especially de Lucca, *Jesuits and Fortifications : The Contribution of the Jesuits to Military Architecture in the Baroque Age*.
237. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", p. 14. I have traced this relationship in Section 2.2.2; its first half corresponds to what Harris identifies as Jesuit ideology, and its result is Jesuit science per se.
238. Ibid., p. 13.

Book	Subject	Description
I	Introduction	Character, division, practices, and terminology of mathematics
II	Arithmetic	Integers, fractions, calculation rules, applications (e.g., astronomy, money, measures, divine purposes)
III	Geometry	Euclid's Elements, Books I–VI
IV	Theoretical trigonometry	Trigonometric functions
V	Practical trigonometry	Angles in triangles, theorems
VI	Practical geometry	Longimetry (measurement of lengths), planimetry (measurement of distances, angles, and areas on a plane), stereometry (measurement of the volume of solid bodies), caelometry (measurement of the volume of hollow bodies), geodesy (division of surfaces), transformations of plane figures, ichnography (art of constructing ground plans)
VII	Cosmography	The terrestrial and celestial spheres
VIII	Theoretical astronomy	Order, motion, position, and size of the planets, the stars, the Sun, and the Moon, eclipses, observed anomalies
IX	Practical astronomy	Description and use of astronomical instruments
X	Astrology	
XI	Chronography	Theory of timekeeping, solar and lunar cycles, determining the ecclesiastical calendar
XII	Geography	Continents, oceans, and climate zones, regional descriptions, measurements and depictions of the globe, latitude and longitude and their calculation
XIII	Hydrography	Surveying and charting bodies of water

Book	Subject	Description
XIV	Horography	Practice of timekeeping, description and use of various types of clocks
XV	Mechanics	Terminology and theorems of moving objects, forces
XVI	Statics	Weight of objects, description and use of instruments of weighing
XVII	Hydrostatics	Measurement of fluids and solid bodies within fluids
XVIII	Hydraulic engineering	Water wells, pipes, fountains
XIX	Optics	The eye, descriptions of visual phenomena
XX	Catoptrics	Study of reflections
XXI	Dioptrics	Study of the refraction of light
XXII	Military architecture	Some groundplans of fortifications
XXIII	Art of war	Besieging, defense, troop positioning
XXIV	On forts and formations	
XXV	Musical theory	
XXVI	Algebra	Addition, subtraction, multiplication, and division of rational numbers, irrational numbers, fractions, and 'letters', equations, radicals, solving methods for specific problems
XXVII	Logarithms	Definition, properties, rule for calculation
XXVIII	New division of mathematics	

Table 2.2.: Contents of Gaspar Schott's *Cursus mathematicus* (1677).

them using both qualitative and quantitative methods. While the qualitative approach, a historical study about the structure, values, and ideals of the Society and their impact on its activity in the sciences, is very insightful in its own right, it is Harris' qualitative approach that I want to pay special attention to. It is relevant for the JSN not only by virtue of its methodology and results, but also because of its nature as a very early example of Digital History, at least in the history of science. After all, the underlying databases, their statistical evaluations, and the corresponding diagrams on Jesuit literary

output in the early modern sciences were compiled with the help of computers.

Unfortunately, the methodological discussions that Harris gives in this regard are rather cursory. They are moreover scattered among the introduction and the third chapter of the thesis, appearing partially in between the descriptions and interpretations of the diagrams which makes them cumbersome to find and somewhat difficult to follow.[239]

The introduction contains the following overall description:

> "From Carlos Sommervogel's exhaustive 12-volume bibliography of Jesuit authors, I have assembled a computer database consisting of three parts. The first part is based on a sample of bibliographical data from the entire range of Jesuit literary output in the period 1540–1780. Its purpose is to establish the pattern of publication in each of six major categories of Jesuit literary activity: theology, history, arts & letters, natural and mathematical sciences, philosophy, and jurisprudence. [...] The second part is based on an exhaustive survey of publications in science. It contains bibliographical information on the approximately six thousand titles in science written by members of the Society from its foundation in 1540 until 1800. The third part, like the scientific bibliography, attempts to be exhaustive. It contains biographical information on the nearly 1600 authors of these writings."[240]

Harris then continues with some basic thoughts on the strengths ("extensive [...] non-selective and balanced overview"[241]) and weaknesses ("do not offer direct access to the 'inner structure' of Jesuit science"[242]) of the quantitative analysis. Later, in the third chapter, he expands a little on the three databases introduced above, and starts from the question after

> "the degree of Jesuit involvement in natural science as compared to other fields of literary activity. A rough but useful index of this was obtained through a random sample of titles listed in volume X, the 'Tables Analytique', of Carlos Sommervogel's *Bibliographie de la Compagnie de Jesus* [sic], prepared by Pierre Bliard, S.J. [...] The titles listed in Bliard's 'Tables' are arranged under five major headings: 'theologie,' [sic] 'jurisprudence,' 'sciences & arts,' 'belles lettres,' and 'geographie [sic] & histoire.' In order to bring Bliard's 'sciences' into closer alignment with the categories of mathematical and natural

239. The pages dealing with the methodology of the qualitative analysis are 18–23, 130–132, 139–142, and 146.
240. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", pp. 18–19.
241. Ibid., p. 21.
242. Ibid., p. 22.

> sciences used in the main part of this study, general works on 'philosophie' and on 'morale' and 'applications de la morale' have been removed from the natural sciences and given their own category, 'philosophy.' Also, from Bliard's fifth category I have taken titles in 'geographie' [sic] and placed them in my category of natural science. Similarly, certain of the titles listed under Bliard's 'archeologie' [sic] (e.g. 'poids et mesures' [sic] and 'inventions') have also been included under natural science. Otherwise, Bliard's categories correspond exactly to the categories used in the sample."[243]

This is followed by a description of how said sample, making up the first of the three databases, is chosen. The other two are covered some pages later. For the first, a bibliographical collection of all works written by Jesuits in the sciences, Harris records "detailed bibliographical information (date, place, and language of publication, classification by topic and form, etc.)",[244] and for the second, a biographical collection of all the corresponding authors, he records "biographical information (date and place of birth, grade within the Society, date, place, and subject of teaching duties, etc.)".[245] Some further pages later, Harris reveals the seven subcategories that he applies to Jesuit science: "Aristotelian themes, mathematics (including 'mixed mathematics'), astronomy, natural and experimental philosophy (acoustics, optics, mechanics, pneumatics, electricity and magnetism), natural history (including descriptive and mathematical geography), medicine & pharmacy, and engineering & technology".[246]

The apparent lack of information concerning the databases—type, size, structure, used software or programming language, the "etc." regarding the type of information collected—can be attributed to the age of the thesis. Although the Digital Humanities go back to the 1960s at least in spirit if not by name,[247] respective standards pertaining to the description of digital projects are only now being developed and codified in the historical sciences.[248] This is an especially great pity with regards to Harris' third database, the one with biographical information on Jesuit authors of writings in the sciences. At least by this account—which is all that Harris gives—it sounds very similar to the database in the Jesuit Science Network and could well serve as preparatory work

243. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", pp. 130–131.
244. Ibid., p. 139.
245. Ibid., p. 140.
246. Ibid., p. 146.
247. Haber, "Zeitgeschichte und Digital Humanities, Version 1.0", p. 2.
248. See Ayers et al., "Guidelines for the Professional Evaluation of Digital Scholarship by Historians", the American Historical Association document I discussed in the Introduction.

or, in an ideal case, even supply data. However, the two projects have very different agendas, and, as is one of the points I hope to bring across in Chapter 3, the research question of a digital project and its implementation are inextricably linked, affecting each other as well as their eventual product. The different agendas hence necessarily lead to a different structure and a different outcome. While Harris is interested in the relationship between Jesuit ideology and Jesuit science and uses his databases as statistical evidence, the JSN is designed to provide an extensive prosopography of Jesuit practitioners in the early modern sciences.[249]

A study of the resulting differences would prove very insightful into the inner workings of Digital History, but that would require not just a verbal description of Harris' databases, but an actual copy of the databases themselves. However, due to their age, they are most likely inaccessible now even if they still exist. The technical advancements in both hard- and software during the past almost 30 years would make it quite difficult to access the data in a sensible way. This just goes to show the utmost importance of developing standards and methods towards a digital sustainability, making sure that research data is stored in a form that remains usable for future generations. I will take up this issue again in Section 5.1 where I consider the challenges of ensuring the long-term operation of the Jesuit Science Network.

Concluding this rather technical-practical digression, I would now like to return to the more content-related aspects of the passages quoted above. In the introduction, Harris writes that he takes all the information for his databases from Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus*. He especially relies on the categorization of the Jesuit literary output provided by Pierre Bliard in volume X in order to set up his own, and adapts it to fit better with the understanding of Jesuit science that he develops in his thesis. Although he describes the changes he makes—for example, sorting out general philosophical writings from the 'arts and sciences' category into one of their own—and provides a short list of the seven subcategories, they still remain somewhat elusive due to the lack of further detail.

It is only in a French follow-up paper of Harris' from 1997[250] that he presents a much more fine-grained stock-taking of Jesuit science. The paper itself deals with teaching positions in mathematics at Jesuit colleges during the seventeenth century, leading up to a diagram plotting the number of colleges against the number of mathematics chairs[251] and closing with a case study on Christoph Scheiner, whom I discussed earlier in

249. See Section 3.1 for an explanation of the aims of the JSN.
250. Steven Harris, "Les chaires de mathématiques", in *Les Jésuites à la Renaissance*, ed. Luce Giard (Paris: Presses Universitaires de France, 1997), pp. 239–261.
251. Ibid., p. 246.

Section 2.2.2. Despite the fact that Harris never explicitly references it, it is obvious from the text that he is relying on the research in his thesis. The revision of his categorization of Jesuit science is halfway through the paper, following the diagram and preceding the case study. Where the old seven categories comprised Aristotelian themes, mathematics (including "mixed mathematics"), astronomy, natural and experimental philosophy (acoustics, optics, mechanics, pneumatics, electricity and magnetism), natural history (including descriptive and mathematical geography), medicine and pharmacy, and engineering and technology, the new supercategories are pure mathematics, mixed mathematics, astronomy, natural philosophy, natural history, medicine, and agriculture and economics.[252] Table 2.3 on page 76 shows the full listing with all of the subcategories as translated from the paper.

Pure mathematics	Algebra, functions, series; analytical geometry; arithmetic; integral calculus and analysis; geometry; logarithms; number theory, probabilities
Mixed mathematics	Mechanics; optics (catoptrics, dioptrics); acoustics (harmonies, theory of music and sound); hydraulics, civil and military architecture; mathematical geography (localization, cartography); scientific instruments, physics cabinets
Astronomy	Calendars, almanachs, ephemerides; clocks (dials, horology); spherical astronomy; lunar and solar astronomy (observation and theory); comets (observation and theory); stellar astronomy (observation); planetary astronomy
Natural philosophy	Commentaries of Aristotle; natural philosophy; philosophy of experience; supernatural and occult questions
Natural history	Cosmography; physical, subterranean, and political geography; hydrography; meteorology (observation, instruments); zoology and botany; cabinets of curiosities, collections
Medicine	Health and disease; anatomy, physiology, surgery; experimental medicine
Agriculture and economics	Woods and horticulture; beekeeping; money, measure and weight

Table 2.3.: Steven Harris' categorization of topics in Jesuit publications in the early modern sciences, 1540–1800.

252. Harris, "Les chaires de mathématiques", pp. 247–249.

Harris deduces this classification from a set of 4770 titles in Jesuit science by a total of 1600 Jesuit authors over the period 1540–1800.[253] Still in his thesis, he cites 6000 titles by the same amount of authors over the same period of time;[254] sadly, neither work provides clues that could explain the difference. But the situation becomes even more confusing when searching Harris' other papers. In a 1989 article, hence one year after his thesis, he counts 1600 Jesuit authors who produced "more than 4000 published works, 600 journal articles (almost all of which appeared after 1700), and 1000 manuscripts"[255] totaled up to 5600 or "nearly 6000 original works, in fields ranging from Aristotelian natural philosophy to astronomy, mathematics (including 'mixed' mathematics), physics (experimental philosophy), natural history, medicine, and engineering"[256] between 1600 and 1773. And in a 1996 paper, one year before the classification cited in Table 2.3, Harris gives a partial tally on Jesuit works in natural history counting "nearly one thousand [1000] published treatises, textbooks, journal articles, reference works, and compendia on topics ranging from descriptive and mathematical geography, hydrography, mineralogy and meteorology to botany, zoology, and what we would now call cultural anthropology"[257] during the seventeenth and eighteenth centuries.

Because the databases are not available and it is only possible to go by what is known from Harris' papers, this problem cannot be resolved. As a purely biographical collection at the moment, the JSN can also only serve to verify the amount of authors.

This issue notwithstanding, the research presented by Harris in his PhD thesis and the 1997 paper is still very valuable. Most of all, it is the only so fine-grained and compact classification of Jesuit science to my knowledge, and as such an indispensable foundation for the work accomplished within the Jesuit Science Network. Of course, that does not mean that there is no other categorization that could not be equally or even better suited to go by. It just means that it is the one that I choose for the JSN; it is easy to understand and work with, it is based on the same source material, the Sommervogel series, it has obviously gone through some editing and streamlining since the 1988 version, and it comprises both the subjects defined by the Cambridge History of Science— natural philosophy, medicine, natural history, cosmography, alchemy and chemistry, magic, astrology, astronomy, acoustics and optics, mechanics, pure mathematics—and the topics that Gaspar Schott included in his *Cursus mathematicus*.

253. Ibid., p. 247.
254. Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", p. 139.
255. Harris, "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition", p. 40.
256. Ibid.
257. Steven Harris, "Confession-Building, Long-Distance Networks, and the Organization of Jesuit Science", *Early Science and Medicine* 1, no. 3 (1996): p. 312.

Chapter 3.

The Jesuit Science Network

> "For their part, scholars who embark upon digital scholarship have a responsibility to be as clear as possible at each stage of conceiving, building, and sharing that scholarship about the implications and significance of using the digital medium for their contribution to the scholarly conversation."[1]

In the previous chapter, in studying aspects of Jesuit activity in the early modern sciences, I laid the foundations for my work in terms of the necessary historical knowledge about and understanding of the period of time, its actors, and their pursuits under consideration. From this chapter on, I will now expand the perspective towards digital historical scholarship (as defined in Chapter 1). From this position, I will introduce, describe, and explain the technical parts of my project—the Jesuit Science Network is a digital prosopography, after all—and while this does include concepts and methods from computer science, all of my decisions and actions "at each stage of conceiving, building, and sharing that scholarship" are deeply rooted in the historical expertise about Jesuit science in the early modern period.

But expertise is necessary on both sides, along with interdisciplinary thinking, as Holger Gast expounds in his very recommendable paper on the approach to databases in historical scholarship:

> "Historians as experts for the meaning and interpretation of data and computer scientists as experts for its technical processing need to have a profound understanding of their own discipline, but also need to be willing to relate to the considerations of the other side."[2]

1. Ayers et al., "Guidelines for the Professional Evaluation of Digital Scholarship by Historians".
2. "Die Historiker als Experten für die Bedeutung und Interpretation der Daten und die Informatiker

Unfortunately, Patrick Sahle reports that computer scientists appear to struggle with this willingness, as well. His account refers to the context of the Digital Humanities, but seeing as digital historical scholarship can be considered part of the DH, it holds just the same:

> "From the point of view of applied computer science, DH mostly deal with technical problem solving, with the application of established concepts and approaches from computer science to questions from the humanities. Not least the ineradicable premise that these are simple problems that can be solved with standard solutions led to the frequent failure of cooperations between the humanities and computer science in the past 30 years."[3]

Influenced by all these reflections, I would like to address the following technical description of the Jesuit Science Network to historians and computer scientists alike.

The already quoted "Guidelines for the Professional Evaluation of Digital Scholarship by Historians", published by the American Historical Association, formulate three responsibilities for scholars doing digital historical work. The first is to explain the "use of digital means to accomplish [...] scholarly goals and the commitment of time and energy" invested, the second is to define departmental and institutional support and evaluation of digital scholarship, and the third is to discuss the "plans for dissemination, sustainability, and preservation".[4] I will respond to the first and third tasks repeatedly throughout this thesis; as for the second one, the unfortunately very short answer is that there is no support available for the time being.[5]

At the same time, I would like to show computer scientists that digital scholarship in the humanities in general and history in particular entails much more than just setting up a database. The fundamental historical research interest and the historical context alike provide new requirements and challenges for the technical implementation time and time again, and there is rarely a one-size-fits-all solution to be found.

---

als Experten für deren technische Verarbeitung müssen dazu jeweils ein tiefes Verständnis ihres eigenen Fachs mitbringen, gleichzeitig aber auch die Bereitschaft, die Überlegungen der jeweils anderen Seite nachzuvollziehen". Gast, "Zum Umgang mit Datenbanken in den Geschichtswissenschaften", p. 250.

3. "Aus Sicht der angewandten Informatik geht es bei den DH meistens um technische Problemlösungen, um die Anwendung etablierter Konzepte und Ansätze aus der Informatik auf Fragestellungen der Geisteswissenschaften. Nicht zuletzt die unausrottbare Startannahme, dass es sich dabei um einfache Probleme handeln würde, die mit Standardlösungen zu behandeln seien, hat in den letzten 30 Jahren zum vielfachen Scheitern geisteswissenschaftlich-informatischer Kooperationen geführt." Sahle, "Digital Humanities? Gibt's doch gar nicht!", p. 10, second paragraph under section 4.

4. Ayers et al., "Guidelines for the Professional Evaluation of Digital Scholarship by Historians", p. 3.

5. As Wuppertal University is about to have a new chair for Digital Humanities soon, I hope that this will change.

3.1. From research interest to research task

Building on the historical context developed in the past chapter, the fundamental research interest behind the Jesuit Science Network concerns four aspects of the activity of Jesuit scholars in the early modern sciences.

Who were they?

To what kinds of subjects did they devote themselves?

Where were they doing so?

And when were they doing so?

This can be further condensed into the *who*, *what*, *where*, and *when* of Jesuit science, the four key questions of this project. The aim of the Jesuit Science Network is then to provide a tool that can help find an answer to these questions. Doing so entails a collective biographical study of the involved actors, in other words a prosopography. Prosopographies can be characterized by four central concepts, "biographical aspect; group aspect; databank and processing; external features".[6] In the case of the JSN, the *who*, *what*, *where*, and *when* clearly provide for the biographical, and the collective description of 'Jesuit scholars in the early modern sciences' for the group aspect. Judging by the plethora of information in Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus* and the extent of Steven Harris' work, see Sections 2.3 and 2.4.2, it is also quite clear that some kind of digital processing has to be involved in the biographical compilation for it to be feasible, at all. The explicit interest in external features finally means that a prosopography does not focus on personal motivations or mentalities, but rather on some kind of chronological CV detailing a person's factual stations in their life. This choice of methodological approach is also fitting because "[p]rosopography is not interested in the unique but in the average, the general and the 'commonness' in the life histories of more or less large numbers of individuals".[7]

Based on the four key questions and the general aim of the JSN, the underlying prosopography should hence meet the following requirements:

1. The prosopography should provide an overview as extensive as possible.

2. The prosopography should allow to answer any combination of the key questions.

6. Koenraad Verboven, Myriam Carlier, and Jan Dumolyn, "A Short Manual to the Art of Prosopography : A Handbook", in *Prosopography Approaches and Applications*, ed. K. S. B. Keats-Rohan (Prosopographica et Genealogica, 2007), pp. 35–69; for a discussion of the use of prosopographies specifically in the study of the history of science, see William Clark, "The Pursuit of the Prosopography of Science", in *The Cambridge History of Science*, ed. David C. Lindberg et al., vol. 4 (Cambridge: Cambridge University Press, 2003), pp. 211–237.

7. Verboven, Carlier, and Dumolyn, "A Short Manual to the Art of Prosopography : A Handbook", p. 37.

3. The prosopography should be realized in such a form that the result can serve as a research tool for others.

The next step, the transformation of this (theoretical) research interest into a (practical) research task, now begins with the realization of the prosopography. This means that an appropriate model for the collective biographical study has to be found. A model, first and foremost, is a simplified representation, in this case of the varied properties and complex relationships held by and between Jesuit scholars in the early modern sciences. As such, a model describes only select traits and is underlying a particular purpose to which these traits are chosen.[8] For instance, the Jesuit Science Network has no interest in the origin of the involved Jesuits, meaning that information about parents and family are disregarded, but cares about education so that the school career is recorded.

The decision to not only collect such a huge amount of information, but also publish it necessarily leads to the use of computers and later on the Internet. Because of that, the model for the prosopography has to be chosen in such a way that it can be processed by a computer, turning it into a so called data model. It is then the data model that eventually allows the execution of complex operations on the collected data, enables a discussion between the developers and the users of the involved software, guarantees consistency and a higher data quality by defining specific conditions for the entry of data, and finally facilitates exchange and conflation of information beyond the framework of the project when adhering to comprehensive standards.[9]

However, creating an appropriate data model and setting up an appropriate digital infrastructure from scratch usually are complex and difficult tasks and cannot be accomplished within the scope of the Jesuit Science Network. What is more, doing so would not be sensible as functioning solutions by third parties are available for use. This is why the JSN relies on the so called Person Data Repository (PDR), a research project at the Berlin-Brandenburg Academy of Sciences and Humanities that has been concluded in spring 2016. Its comprehensive and fine-grained data model is geared specifically towards the representation of persons and their biographical information; in Section 3.4, I am addressing the project and its structure in more detail. In order to differentiate the specific application of this model within the Jesuit Science Network, which only uses a select number of its biographical properties, I will be referring to it as the JSN instance of

8. Fotis Jannidis, "Grundlagen der Datenmodellierung", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), provides an introduction into data modeling suitable for scholars in the humanities; Vladimir Pantic, *Model Based Environment : A Practical Guide for Data Model Implementation with examples in PowerDesigner* (Trafford Publishing, 2013), is an expert-level description from the point of view of computer science.

9. Jannidis, "Grundlagen der Datenmodellierung", p. 100.

the PDR model. While the underlying model and the infrastructure are provided by the Person Data Repository, the Jesuit Science Network alone is responsible for its model instance.

With the necessary terminology now defined, I can rephrase the above conditions as follows:

1. The database should cater to a data model as general as possible and as particular as necessary.
2. The database should allow for complex searchability of the information contained.
3. The database data should be accessible via a corresponding project website.[10]

As a result, it is possible to project a couple of basic work stages that shape the further planning and realization of the Jesuit Science Network.

- Determine the sources that can be used for the collection of biographical data.
- Given those sources, determine what kind of biographical data should be collected and, based on the Person Data Repository data model, develop a respective model instance.
- Set up the digital infrastructure.
- Enter the data.
- Design the project website and implement the search, display, and possible visualization and/or evaluation functionalities.

The creation of an appropriate model instance both calls for a historian's understanding of the topic at hand as well as a technical understanding of the used infrastructure and model. As separate as these spheres of knowledge usually are, they have to work together to make things happen in projects like the Jesuit Science Network, and they even depend on each other—while the historical mind defines what it is looking for and why it is looking for it, the technical mind sets boundaries to what is realistically possible. Then both sides have to collaborate to come to a balanced compromise between the desired and the achievable, and both are equally involved in helping the project succeed.

10. Much to my regret, I unfortunately do not have the means to ensure that the JSN is accessible without any restrictions for users who experience disabilities.

3.2. Data sources

While the Jesuit Science Network is not to be misunderstood as any kind of succession to the work done by Steven Harris and thus pursues different goals with different methods, it draws some orientation from it. Aside from the already discussed list of subjects,[11] this particularly pertains to the very source upon which both studies are based: Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus*.[12] Due to the sheer quantity of information it provides, the *Bibliothèque* has generally become a standard reference for any kind of historic research on the Society of Jesus, but it also brings along some challenges that have to be addressed.

In terms of practical work, the two biggest issues with the *Bibliothèque* concern its consistent use of the French versions of given names along with outdated place names. While the latter comes naturally with the age of the series—it is over 100 years old, after all—and is thus not further surprising, the former might baffle the mind a bit. Depending on the reader's familiarity with local or national name variants and their French counterparts, it can become quite difficult to properly identify a person, only adding to the conventions (or lack thereof) around early modern naming schemes. As for the outdated place names, there are numerous online-based services, but also printed dictionaries providing lists of historical names and their modern counterparts. Wikipedia has turned out especially helpful in this regard. Its community seems to have a partiality for articles recounting historical facts in their proper chronology,[13] to which municipal histories certainly belong, so that they are often well researched, written, and reviewed, and particularly also contain outdated toponyms. The user can even better the odds by searching various language versions of Wikipedia (with the French, English, and German ones being the usual suspects), especially if they can gather from the context of a Sommervogel entry which modern country the sought-after place could belong to. However, sometimes places can also not be located properly or at all due to their small size, or due to several places with the same name existing close to each other, and then no online- nor offline-service will be of much help.

In order to illustrate the effort that comes with 'translating' the *Bibliothèque* for its use within the Jesuit Science Network, I want to present an example from volume II.[14]

11. See Table 2.3 on page 76.
12. The *Bibliothèque* was introduced in Section 2.3.
13. Jürgen Nemitz, "Wikipedia in der historischen Lehre", in *Wikipedia und Geschichtswissenschaft*, ed. Thomas Wozniak, Jürgen Nemitz, and Uwe Rohwedder (De Gruyter, 2015), pp. 57–58.
14. On the issue of adapting old geographical names into their modern-day variant, please see Sections 3.5 and 3.7 on data entry and the project website, respectively.

There, column 456 introduces Jean-Baptiste Horvath. His place of birth is given as Gran or Güns in 1732. After he entered the Society in Trentschin in 1751, he worked as a college prefect in Tyrnau, taught physics and philosophy in Tyrnau and Buda, and was chosen to be an abbot in Egra, before he died in Pesth in 1799. In this case, Gran, Güns, Trentschin, Tyrnau, Buda, and Pesth are the old German names of modern-day Esztergom (Hungary), Kőszeg (Hungary), Trenčín (Slovakia), Trnava (Slovakia), and the two cities which were later fused to Budapest (Hungary), while Egra is the French version of Cheb (Czech Republic). Looking up the VIAF[15] for Horvath himself furthermore reveals at least six different variants/spellings of his name, albeit not containing Sommervogel's French Jean-Baptiste: Ivan Krstitelj Horvath (preferred spelling of the National and University Library in Zagreb), Keresztelö János Horváth (National Library of Catalonia and ISNI), János Horváth (National Széchényi Library, Hungary), Johann Baptist Horváth (National Library of Poland and German National Library), Johann Baptiste Horvath (Wikidata), Joan. Bapt. Horvath (National Library of the Netherlands), Ján Krstitel' Horváth (National Library of the Czech Republic), and Joan. Bapt (Joannes Baptista) Horvath (National Library of Australia).

The decision to base the Jesuit Science Network on the *Bibliothèque*, however, also has conceptual ramifications. The series offers only very elementary biographies whose contents of course are dependent on what Sommervogel and his collaborators were able to access in the first place, both with regards to language and sheer availability. The information about Horvath quoted above, for example, is all that Sommervogel relays about his life condensed in merely seven lines, although they are followed by the scholar's bibliography spanning almost four and a half columns. This pretty skewed ratio between biographical and bibliographical part is typical for the series.

To a certain degree, all of these three issues can be alleviated or even resolved through the use of additional, primarily modern sources which both extend the scope of Sommervogel and use modern and/or contemporary vernacular names for geographical

15. The VIAF, short for Virtual International Authority File, is an online service that combines a number of national and regional-level name authority files. Authority files or authority control are a concept from library science, serving to organize all occurring forms of names, subjects, titles, etc. concerning bibliographical information. A name authority file, hence, contains all occurring spelling variants of an author's name. The VIAF project was initiated by the Library of Congress, the Deutsche Nationalbibliothek, the Bibliothèque nationale de France, and its operator, the OCLC (Online Computer Library Center). It currently incorporates information from 37 agencies in 29 countries, among them many national libraries. The existence of an international authority file thus implies the existence of at least one national authority file such as the German GND (Gemeinsame Normdatei) or the existence of an entry in an online database such as Wikidata. The VIAF catalog can be searched through a website, `https://viaf.org/`, or directly queried via an API. For more information on the GND, see Barbara Pfeifer, "Über Zweck und Nutzen der Gemeinsamen Normdatei (GND)", in *Jahrbuch für Universitätsgeschichte*, ed. Oliver Auge and Swantje Piotrowski (Stuttgart: Franz Steiner Verlag, 2013), pp. 251–260.

places as well as given names. The most extensive of these sources that does not have a particular geographical focus is the *Diccionario Histórico de la Compañía de Jesús* published in 2001.[16] The *Diccionario*, or DHCJ for short, is a four-volume historical dictionary on the Society of Jesus in Spanish. It consists of mostly short to medium-length articles not only on people, but also places, institutions, and even subjects connected to or treated by the Jesuits. In contrast to the Sommervogel series, where entries are not signed and overall appear very homogeneous, each article in the DHCJ is attributed to its respective author and slightly differs in tone. To illustrate what this means and what kind of effect it has on the JSN, I picked two examples from the first volume of the *Diccionario*, P. Duclos' article on Louis-Bertrand Castel and M. Batllori's article on Tomás Cerdà. The biography on Castel begins as follows:

> "He showed such fondness for scientific speculation in his essays that he caught the attention of René-Joseph de Tournemine and Bernard Le Bovier de Fontenelle. Having left Toulouse (1720) with an assignment for the college Louis-le-Grand in Paris, he also contributed to the Journals *Journal de Trévoux* and *Mercure de France*. A scientific polygraph, he gained fame for his three general explications on physics, mathematics, and optics."[17]

Aside from the basic dates of birth, death, entry, and ordination in the header, common to all biographical entries, in the DHCJ, Duclos mentions only one more year. Instead, he focuses on giving a characteristic of Castel, his work, and his published writings. Batllori's account on Cerdà, on the contrary, reads very different:

> "Having finished the humanities in Tarragona (1733–1734), his studies of philosophy in Gandía (1734–1737), and of theology in Valencia (1737–1741), he first taught the humanities in Lérida (1741–1742) and later rhetoric in Manresa (1742–1743) and again Lérida (1743–1746). After his third probation in Tarragona (1746–1747), he taught philosophy to Jesuit youth at the residency of Father Eterno in Zaragoza (1747–1750) and at the university of Cervera (1750–1753)."[18]

16. O'Neill et al., *Diccionario Histórico de la Compañía de Jesús*.

17. "En sus ensayos mostraba tal afición por la especulación científica, que llamó la atención de René-Joseph de Tournemine y de Bernard Le Bovier de Fontenelle. Pasó destinado (1720) de Toulouse al Colegio Louis-le-Grand de París, donde colaboró en las revistas el *Journal de Trévoux* y el *Mercure de France*. Polígrafo científico, adquirió celebridad por tres de sus explicaciones generales en física, matemáticas y óptica." P. Duclos, "Castel, Louis-Betrand", in *Diccionario histórico de la Compañía de Jesús*, ed. Charles O'Neill, vol. I (Madrid: Universidad Pontifica Comillas, 2001), col. 699.

18. "Terminado al repaso de humanidades en Tarragona (1733–1734) y sus estudios de filosofía en Gandía

Batllori thus clearly provides the *what*, *where*, and *when* of Cerdà's life, and continues to do so throughout the article; he, too, elaborates more on the Jesuit's work and influence on others, but with a lot more details that can easily be taken down in the form of a tabular CV.

Aside from the regionally overarching *Bibliothèque* and *Diccionario*, there are also a number of sources that focus on a specific geographical region or even just a specific college. In the following, I will present and comment on some chosen examples; a complete list of sources used for the Jesuit Science Network can be found in the appendix in Appendix A.2.

- Bogdan Lisiak's *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*[19] (Polish Jesuits and the exact sciences from the sixteenth to the nineteenth centuries: a bio-bibliographical dictionary) from 2000 is a Polish collection of 37 biographies of Jesuit scholars based in the Polish-Lithuanian Commonwealth.[20] Lisiak names architecture, astronomy, engineering, hydraulics, mathematics, the natural sciences, and physics as their major areas of activity. The respective entries are quite homogeneous in quantity and quality of information and often use Sommervogel as one of their references, but Lisiak also calls upon additional, mostly Polish sources and literature. Each entry is followed by a mid-length catalog of the works authored by the particular Jesuit, and sometimes holds titles that the *Bibliothèque* does not mention. It is particularly noteworthy that this monograph gives a lot of insight into the relationships between Jesuits, at least as far as these are recorded by the sources; for example, it is often remarked upon who was teaching or working with whom. A particular research question provided, information like this can be evaluated within the context of network analysis, see Section 5.3.

- In 1999 and 2002, Georg Schuppener presented *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)* (Jesuit mathematics in Prague in the sixteenth and seventeenth centuries) and *Prager Jesuiten-Mathematik von 1600–1740* (Jesuit mathematics in Prague between 1600–1740), two works on Jesuit mathematics at

(1734–1737) y de teología en Valencia (1737–1741), enseñó, primero, las humanidades en Lérida (1741–1742) y, luego, retórica en Manresa (1742–1743) y en Lérida (1743–1746). Tras la tercera probación en Tarragona (1746–1747), explicó, durante un trienio, filosofía a los jóvenes jesuitas en la residencia del Padre Eterno, en Zaragoza (1747–1750) y en la Universidad de Cervera (1750–1753)." M. Batllori, "Cerdà, Tomás", in *Diccionario histórico de la Compañía de Jesús*, ed. Charles O'Neill, vol. I (Madrid: Universidad Pontifica Comillas, 2001), col. 734.

19. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*.

20. Since I use the group of Jesuits described by Lisiak as a sample and case study for the showcasing of the Jesuit Science Network in Chapter 4, his work is of particular significance for this thesis.

the Clementinum in Prague,[21] the local Jesuit college that was later merged into Charles University. While both focus on the development and content of Jesuit mathematical studies at the Clementinum, they also include a part with very short, tabular CVs of those Jesuits who came to work at the college at one point in their life. Bibliographies are not given.

- Having spoken of these very recent studies, I would like to also include some older works that, while still younger than the *Bibliothèque* itself, already do show their age. One of them is Maria Reindl's *Lehre und Forschung in Mathematik und Naturwissenschaften, insbesondere Astronomie, an der Universität Würzburg von der Gründung bis zum Beginn des 20. Jahrhunderts* (Teaching and research in mathematics and the natural sciences, especially astronomy, at the University of Würzburg from its foundation to the beginning of the twentieth century) from 1966.[22] This little booklet lists all the scholars who taught or did research in the sciences at the University of Würzburg, among whom were also many Jesuits. The biographies given are very rudimentary (rarely longer than half a page) and often feature remarks specific to activities or events in Würzburg; their main benefit lies in supplying additional names.

  The other source or rather set of sources that I want to mention here was written by Karl Fischer. Based on the internal catalogs kept at Jesuit colleges, Fischer compiled lists of *mathematici*, i.e. Jesuit students and teachers in the mathematical sciences, in select Jesuit assistancies and published them as "Jesuiten-Mathematiker in der deutschen Assistenz bis 1773" (Jesuit mathematicians in the German assistance), "Jesuiten-Mathematiker in der französischen und italienischen Assistenz bis 1762 bzw. 1773" (Jesuit mathematicians in the French and Italian assistancies), and "Die Jesuiten-Mathematiker des nordostdeutschen Kulturgebietes" (The Jesuit mathematicians of the North-East German culture area) in 1978, 1983, and 1984 respectively.[23] These articles provide a mere lineup of colleges where an explicit mathematical education was offered along with the Jesuit scholars involved, for whom dates and places of birth and death are also given. Hence, similar to Reindl's

21. Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*; Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740*.

22. Reindl, *Lehre und Forschung in Mathematik und Naturwissenschaften, insbesondere Astronomie, an der Universität Würzburg von der Gründung bis zum Beginn des 20. Jahrhunderts*.

23. Karl Fischer, "Jesuiten-Mathematiker in der deutschen Assistenz bis 1773", *Archivum Historicum Societatis Iesu* 47 (1978): pp. 159–224; Karl Fischer, "Jesuiten-Mathematiker in der französischen und italienischen Assistenz bis 1762 bzw. 1773", *Archivum Historicum Societatis Iesu* 52 (1983): pp. 52–92; Karl Fischer, "Die Jesuiten-Mathematiker des nordostdeutschen Kulturgebietes", *Archives internationales d'histoire des sciences* 34, no. 112 (1984): pp. 124–162.

booklet, their benefit lies in supplying additional names.

From the point of view of a historian, it naturally seems desirable to collect all information available from all sources available; just the few examples I have just presented illustrate how much material there is. However, such a high degree of variation in form and content leads to methodological problems; as the information that has to be processed becomes increasingly heterogeneous, the creation of a unifying model instance becomes increasingly more difficult since the gap between 'as detailed as necessary' and 'as general as possible' continues to widen, all of which in turn has an impact on the search functionalities of the finished product. An even bigger problem is that this also heavily affects any possible evaluations and visualizations of the resulting data. To give an example, Lisiak's monograph speaks most consistently of interpersonal relationships between Jesuit scholars in the early modern sciences, while Sommervogel rarely makes any mention of them. An analysis based merely on the data from these findings might now falsely suggest that the Polish-Lithuanian Jesuits were the only ones corresponding, when it is, in fact, a matter of a poor body of sources.

Of course this is a danger that is inherent to all such heterogeneous data collections, but the lack of information and its interpretation are particularly tricky aspects of dealing with historical data. Not only is there no way of filling in the gaps if there simply is no source material; what is more, the historical context has to be kept in mind at all times in order to ensure that technically valid evaluations or visualizations that make no sense against the historical interpretation, will be safely discarded.

Finally, having to handle so many sources also comes with the task of having to handle the many languages in which they are written. Just the works examine above already account for French, Spanish, Polish, and German, but there are other sources used in the Jesuit Science Network in English, Italian, and occasionally even Hungarian. All in all, the danger of getting lost in translation on the way of consolidation is rather high, and the consolidation itself is a challenge that I will discuss in the next subsection.

The question remains as to how to tackle all these issues. The most straightforward and simple solution would be to restrict the Jesuit Science Network to Sommervogel's *Bibliothèque* as its only source of information, for example in an alpha version. One could thus possibly keep the outdated place names and French spelling variants, cautiously annotating them with the help of VIAF and online geolocation services;[24] in a second

24. In the course of the work it turned out that the Person Data Repository actually allows to use the outdated toponyms in clear text and provide modern versions and coordinates in the meta data. Like so many other things, I only learned of this feature—that admittedly had been there from the start—when I had already established 'my own way' without it.

step, one could then extend the system gradually for the use of modern sources, one at a time.

While not without its merits especially in terms of precision, this method has two major disadvantages. First, it requires a certain foresight into the execution of the Jesuit Science Network that I simply did not have, either for lack of experience with digital projects or because issues only appeared during practical work; and second, it requires a significantly higher amount of time and labor, thus making it unsuitable for the realization within a PhD study. I hence quite naturally went with the other possible route of just getting starting and including every kind of source from the very start, taking on problems as they appeared.

3.3. Information to be collected

First having determined the data sources for the Jesuit Science Network on the previous pages, the second step is now to set up the model instance, i.e., to specify what kind of information about Jesuit scholars in the early modern sciences should be collected. Of course, I have yet to properly introduce the digital infrastructure on which the model instance works, and so it might seem like I am putting the cart before the horse. However, while the inherent linearity of written reports and my similarly linear list of work stages on page 83 might suggest that all these tasks were carried out one after the other, many of them could or even had to be worked on simultaneously. The biographical categories of interest for the JSN in particular easily carried over from the first hand-written lists at the very beginning of the project to the finalized model instance saved as a file within the Person Data Repository. For these reasons it is sensible to speak of the model instance before detailing the infrastructure itself.

Thus back to the problem at hand. Based on the sources, the prosopographical approach, as well as the historical interest of the project, the above mentioned biographical categories of interest came along quite naturally: general biographical data about life, death, and membership in the Jesuit order, education and further career, relations with other people, and the obligatory miscellaneous section for everything that would not fit anywhere else. While this structure remained the same from its first draft to the final implemented form of the model instance, testing the model with sample data and, most of all, setting up the digital infrastructure resulted in adaptations to its finer details.

The biggest difference between the very first and the final renditions, however, is that in the beginning, the Jesuit Science Network was also supposed to function as a bibliographical database. In addition to the biographical part on the Jesuit scholars, the

Biographical structure
Intro
Name
Picture
Personal profile
Name
Date and place of birth
Date and place of death
Entry in the order
Profession
Short biography
Education and career
Education
Career
Teaching (and fields of activity)
Network
Other
Bibliography
Secondary literature

(a) Biographical structure

Bibliographical structure
Intro
Author
Title
Frontispiece and/or title page
General information
Date and place of publication
Publisher
Number of pages
Number of tables/images
Format
Link to digitized version
Table of contents
References and reception

(b) Bibliographical structure

Table 3.1.: First draft of the model instance for the Jesuit Science Network.

JSN was projected to provide extensive bibliographical information on their respective written works. In the final product, each person's entry was to have a Bibliography category where each item would link to this particular item's own entry—and bibliographical details—in turn. Table 3.1 on page 91 hence shows a model instance draft in two parts, one for the biographical and one for the bibliographical structure. This particular draft is the result of the very first few weeks of work on the project, even before the search for an appropriate digital infrastructure had started, and the very first time any thoughts about the future Jesuit Science Network were put into writing.

The overall division and especially the use of the Intro category indicate that this first draft was already made with an online presence for the JSN in mind which, at that time, was yet unplanned and entirely out of reach. The idea was that the model design should mirror the website design—certainly a possible, but not necessarily practical approach.

It was eventually scrapped when the actual technical infrastructure for the project was set up.

Concerning the further details of Table 3.1a, the initially mentioned categories—general biographical data about life, death, and membership in the Jesuit order, education and further career, relations with other people, miscellaneous—are already visible, but not yet properly worked out. Some of the fields furthermore overlap, such as the 'Short biography' with pretty much everything else, making it obvious that this structure needed to be refined more precisely.

Of particular interest are also the fields Picture and Profession as well as Bibliography and Secondary literature. The integration of some kind of effigy for each person, if available, was initially planned to be done manually during the input of information into the future database, but since having an image was deemed of rather minor importance and the proposed way of a manual search would of course be highly impractical, the idea was dropped for the time being. However, because the online search for specific images is a task that can be automated within reason, the integration of effigies could be taken up again during a future update to the project website.

The intention of the Profession field in Table 3.1a was to provide a classification similarly to the one employed by Lisiak in his monograph. There, each person has a label such as mathematician, architect, physicist, etc. just below their name, which allows the reader to grasp said person's main field of activity by just one look. However, albeit the labels admittedly 'feel' right, Lisiak does not give any further insight on how they were chosen. What is even more problematic, twice he uses the description "popularyzator",[25] popularizer, whereas the concept of popularization is associated rather with the nineteenth century than the early modern period.[26] Hence attempting to set up a similar classification scheme for the JSN would ultimately suffer from the same lack of proper historical reasoning. In addition, the often times poor body of sources would not always allow to even pick a label in the first place. The Profession field was hence removed in further revisions of the draft.

The two categories now remaining to be discussed, Bibliography and Secondary literature, account for the originally twofold bio-bibliographical scope of the JSN. As described above, the Bibliography category was supposed to contain a list of the respective Jesuit scholars' written works and, for each list item, link to a separate entry with the information seen in Table 3.1b. 'Secondary literature', then, would simply contain

25. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, pp. 145, 151.

26. On the history of the popularization of science, see, for instance, Peter Bowler, "The Popularisation of Science", Leibniz Institute of European History (IEG), 2015, accessed 09/26/2017.

the references for the collected biographical information, but this category became obsolete with the implementation of the Person Data Repository because its infrastructure provided a different solution. I will return to this point in the next subsection.

At this point I would like to insert a brief methodological observation. The proposed first (and only) draft of a bibliographical structure for the Jesuit Science Network was not just governed by historical interests and an aspiration to deliver a product as thorough and complete as possible, but also by a misguided belief in how easy the actual implementation would be. The mere availability of digital solutions does not bear any witness to the effort and complexity required in their use, be it in terms of technical or practical requirements. A bibliographical collection based on Sommervogel, for example, would of course be highly desirable, but in the light of the overwhelming amount of information provided by the *Bibliothèque*, compiling it in a digital database and furthermore editing and enriching it for the display on a corresponding website would be more than enough work for several years.[27] In addition, one has to keep in mind that a digital bibliography requires a different internal and technical setup than a digital biography, further complicating the search for an appropriate technical infrastructure. Hence, despite the initial aspiration to combine both, I decided that the Jesuit Science Network would focus only on the biographical data, albeit the option of a later bibliographical extension is still open.

As briefly touched on at the very beginning of this subsection, there was, next to the rather fundamental decisions discussed above, also a number of changes to the finer details of the model instance. They were, in part, the consequence of testing; applying the scheme to the biographies of several both well- and lesser-known Jesuit scholars showed to which degree it suited the given information and where it had to be adjusted. Hence, the resulting changes are of a practical, externally visible nature. The other part of adaptations, however, was due to the implementation of the JSN scheme within the chosen digital infrastructure. They are thus of an internal and invisible nature, mostly concerning the way in which data has to be entered as well as the way it is marked up. I will further expand specifically on what markup is and how it is used in the case of my project in the next subsection, but before I get to that, I want to present and discuss the final model instance of the Jesuit Science Network.

27. The feasibility of compiling these bibliographies mostly hinges on its degree of possible automation. Searching and collecting bibliographical data from the OPACs of libraries might already be done by a script, but without a sufficiently OCRed and marked-up digitalization of the Sommervogel series, the list of works itself would still have to be transferred from the books by hand. At the time of writing these lines, the Göttingen Digitisation Centre at the Göttingen State and University Library, Germany, is in the process of working on just such an OCRed version; it is unknown, however, when it will be finished. Scans of

Name	**Education**	**Miscellaneous**
Norm name	Date	Relations
Alternate spellings	Place	'True' miscellaneous
VIAF	Subject	
Biographical data	**Career**	
Date and place of birth	Date	
Date and place of death	Place	
Entry in the order	Subject	
Resignation	Occupation	
Expulsion		

Table 3.2.: The final model instance of the Jesuit Science Network.

Table 3.2 on page 94 shows how much more condensed, but also tidy and logical the final structure is in comparison to the first draft in Table 3.1a. Instead of using the imagined future project website for guidance, the final scheme is built just like a simple tabular CV that allows to mirror a person's biography much better. The categories—Name, Biographical data, Education, Career, Relations, and Miscellaneous—are clearly separated from each other, with the exception of personal relations now being a part of Miscellaneous; this ordering was brought about by the way that relationships are handled by the infrastructure and the formatting choice for data input, hence a technical decision. At the same time, however, it accommodates the fact that personal relations are as flexible as any kind of information that would be filed under Miscellaneous. The most common types of relationships that can be found with Jesuit scholars encompass teachers and students, predecessors and successors, general collaboration, sometimes also general animosity, the exchange of letters, influence,[28] family relations, and employment or positions outside of the Society, such as private tutoring of noble sons, or an appointment as royal mathematician. As can be seen by these examples, the classification of relations is rather fluid, and it can be quite tricky to find a proper description in some cases.

To go over the other individual categories and the items therein, the first category of the structure is dedicated to a person's name. As it was already brought up in the part about Sommervogel's use of French name variants, the difficulty of dealing with early modern names is that the period had no consistent naming scheme yet; often times, vernacular variants, possibly even with several different spellings, coexisted with a Latin

Sommervogel are already available online as PDF and can be found through the Göttingen library OPAC.

28. The source material sometimes comments on the scholars or books which a Jesuit followed, here described with 'influence'.

version. Hence, for the sake of completeness as well as in order to determine a specific norm name, i.e., a standard display name of a person, it was decided to refer to the VIAF.[29] In practice this means that during data entry, the designated norm name in the Jesuit Science Network is chosen to be same as the designated norm name in the VIAF, and all the other spelling variants are to be automatically imported later in the project website. For that purpose, the VIAF-own identifier is recorded in the JSN, as well.

True to its name, the 'Biographical data' category contains some very basic information on a person's biography, namely the dates and places of birth and death along with some Jesuit-specific information on a Jesuit's entry in the Society and, in a few cases, resignation or expulsion.

The Education and Career categories are very similar in their structure. Both ask for date, place, and subject treated; in addition to that, Career also comprises the option to enter an Occupation. Mindful of my earlier discussion of what the pursuit of the sciences meant for an early modern scholar,[30] this term is not to be taken in its modern conception of a job chosen according to a person's individual abilities, interests, and taste; instead, I use occupation in the sense of an activity that one engages in regularly in order to mirror the information given by the sources. For instance, if the source comments on a Jesuit teaching a subject at a college, then I would take his occupation down as Teacher, and a Jesuit on a mission would be Missionary, perhaps also serving as Preacher or Confessor.[31]

However, there are also some substantial simplifications in this regard. Due to the heterogeneity of the sources concerning quantity, quality, and language of information, and the aspiration of the Jesuit Science Network that was conceptualized as an English-language, consolidated biographical collection, any occupational descriptors have to be streamlined to a certain degree. Attention to detail has to be sacrificed in favor of the scope that can be covered and the required amount of work. Sometimes this even leads to the omission of certain life stations, especially when they are not concerned with the early modern sciences in any way. In addition, the information given by the sources is often too vague or too complex to easily pick an occupation.

The need to streamline data entry and maintenance also caused two finer details, initially desired for the Education and Career categories, to be dismissed quite early. Aside from recording the place and date, it was planned to additionally specify the type of institution where the scholar was taught and/or worked; however, it quickly became

29. For an explanation of the VIAF, please refer to footnote 15 on page 85.
30. See Section 2.1, page 26 and following.
31. In addition, I would like to make the point that this occupational information is markedly different from the generalizing and categorizing labels that Lisiak uses in his monograph, see page 92.

apparent that the sources very rarely give this kind of information at all, and content themselves with just naming the city (though they sometimes do not even do that). This is particularly striking in the case of Rome. Despite it being the home to many Jesuit educational institutions, the sources seldom specify which of the colleges located there is meant in particular. In summary, the low rate of return of this type of information rendered its recording meaningless. For the very same reason, the achieved scholarly degrees were removed from the scheme.

I would now like to conclude the presentation of the Jesuit Science Network model instance with a couple of remarks. Firstly, although the final version of the biographical structure in Table 3.2 had to omit or simplify certain types of information, the information per se is not lost. As mentioned above, the digital infrastructure allows for a very precise referencing of the data with its respective sources, meaning that a curious user can still look up the complete biographies and see if something had to be left out.[32]

Secondly, it should be noted that not all fields given have to be filled during data entry; after all, the sources do not necessarily give all the hoped-for information in the first place. However, the technical infrastructure makes it possible to annotate all entries, even empty ones.

And thirdly, the particular choice described here certainly does not constitute the ultima ratio. It is rather one possible result of the task of creating a biographical database and depends on many subjective choices: the sources to use, what kind of information to look for, translation and consolidation, choice of infrastructure along with the influence of the infrastructure itself. It is thus absolutely possible to have somebody else solve the same task with a very different outcome, but that would not render one of the results better, worse, or even wrong. It would just prove once more how multifaceted projects in the Digital Humanities are and how much, maybe even more so than 'traditionally analog' research, they depend on the perspective of the researchers involved.

3.4. Digital infrastructure: Person Data Repository

One of the certainly most challenging aspects of realizing the Jesuit Science Network was the search for and setup of an appropriate technical infrastructure. This includes the biographical database as well as its online point of access, the project website, setting two very different but equally important tasks. Having gone about this project with

32. In general, the more formulaic the resource, the more information can be transfered into the Jesuit Science Network. This is independent of the writing style—continuous vs. tabular text—and instead relies on the writing intent of the author of the text.

no prior knowledge on Digital Humanities work whatsoever, and often guided merely by a sort of 'technical gut feeling' about what seemed a sensible thing to do, I do not want to discuss various approaches along with their pros and cons now that I have the appropriate experience in hindsight—that would neither be honest nor reflect my actual work. So, as often happens in general, it was simply talking to the right people at the right time that first brought me in touch with a project called the Person Data Repository (2009–2016), or PDR for short, at the Berlin-Brandenburg Academy of Sciences and Humanities. The PDR quickly became the infrastructure of choice for my work.

Part of the in-house TELOTA[33] action, the PDR was originally developed as a tool for Academy research dealing specifically with prosopographical information. As such, its goal was to provide internal projects with a repository to store, access, and share their collected data.[34] However, the scope of the PDR was soon broadened to also support outside projects such as Musici and MusMig, two international research groups studying different aspects of musicians in early modern Europe.[35] Just as the Jesuit Science Network, both rely on the internal structure and the software developed by the PDR team. This dependency is of course highly problematic in terms of long-term operation, and in fact, the conclusion of the Person Data Repository in spring 2016 effectively ended any further development and even maintenance. I will address this issue later on in Section 5.1.

The PDR infrastructure revolves around a data model where each person is treated like a pin board, and each particular piece of biographical information about them—their name, date of birth, familial relationship to a sibling—is one particular note pinned to the board. Such a pin is also called an aspect; a person's biography is thus contained in the entirety of their aspects.

The big advantage of a real-life pin board is of course that it is easy to add, edit, and remove pins to, on, and from the board at all times, and that it is also possible to have pins containing contradicting information, for example two different spellings of a name. These advantages translate directly to the PDR model and its use of aspects. In

33. TELOTA, The Electronic Life of the Academy, can be described as its Digital Humanities initiative. It is aimed to provide a common digital infrastructure for Academy projects. Further information can be found on `http://www.bbaw.de/telota` in German and `http://www.bbaw.de/en/telota` in English, respectively. Both accessed 08/22/2017.

34. Gerald Neumann et al., "Personendaten-Repositorium (PDR)", in *Berlin-Brandenburgische Akademie der Wissenschaften : Jahrbuch 2010* (Berlin: Akademie Verlag, 2010), pp. 320–326.

35. The Musici project website, `http://www.musici.eu`, is available in Italian, German, and French. Its complete German title translates to "European musicians in Venice, Rome, and Naples (1650–1750). Music, national identity, and cultural exchange". The MusMig website can be reached at `http://www.musmig.eu`; the complete project title is "Music Migrations in the Early Modern Age: the Meeting of the European East, West and South".

addition, each aspect requires a source citation; it cannot be added without it. This feature is an immediate result of the humanities background of the Person Data Repository developers and their knowledge about the needs and demands of humanities research, in this case any historian's need for proper citation. While a seemingly small thing, this constitutes one of the reasons behind choosing the PDR as the infrastructure for the Jesuit Science Network. It furthermore illustrates why Digital Humanities projects very often cannot just use already existing models or software from non-DH contexts; these were designed for a different purpose, lack specialized but necessary functionalities such as requiring a citation, and might generally not fit the research interest, methodology, or existing internal modeling.

Along with their new data model, the PDR team also developed an application called the Archive Editor for the actual practical work with the research data. The data itself is first stored locally and then, in a second step, uploaded to an online repository—hence the name, Person Data Repository. By default, this repository is set up on a server owned by the Academy.[36] While some very general biographical data like a person's name and date/place of birth can be viewed by all projects working with the PDR, each project has their own repository space, and the entirety of the uploaded data can only be viewed and edited by its respective owner.

I would now like to turn my attention to some internal aspects of collecting, structuring, and organizing data within the PDR, that is, the XML database that comes into use in the project. While this is not meant to be an introduction into databases in general or XML in particular,[37] I want to briefly address some of the properties of XML and how and why a prosopographical collection such as the Jesuit Science Network greatly benefits from this type of technical approach.[38]

XML stands for Extensible Markup Language. Markup languages provide a way to annotate textual data with information about its structure or other attributes that do not rely on direct, visible formatting, and instead use indirect descriptions that are both human- and machine-readable. The entirety of these descriptions, the so called markup, can then be processed and its results displayed by an appropriate application.

36. There is also the option to establish a local, isolated repository to which only its owning project has access, provided the required server space is available.

37. See, for example, Harald Klinke, "Datenbanken", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), pp. 109–127, and Georg Vogeler and Patrick Sahle, "XML", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), both geared towards scholars in the humanities.

38. Further information about the PDR specifications can be found on the project Wiki under `https://pdrprod.bbaw.de/wiki/doku.php?id=en:start`. Please note that the the English version, while existing, is not as detailed as the German one. In addition, the Wiki has not been updated since early 2014.

XML in particular was designed with a focus on the structuring of documents, along with the goal of being soft- and hardware-independent. Since XML files can hence be read and edited on any kind of system that comes with a simple text editor, this format is predestined for the storage and exchange of data. In contrast to most other markup languages that come with a fixed set of predefined markup, XML furthermore allows its users to make their own and thus finely adapt it to their particular needs—hence the 'extensible' part of the name.[39]

To provide an example, Listing 3.1 on page 99 shows how a simple note, a reminder from Luigi to Mario to not forget him this weekend, can be described in XML.

```
<note>
  <to>Mario</to>
  <from>Luigi</from>
  <heading>Reminder</heading>
  <body>Don't forget me this weekend!</body>
</note>
```

Listing 3.1: Setting a note in XML.

The code can easily be read and understood as is. It furthermore does not 'do' anything with the information it describes, it just provides a structure and labels the particular parts of the note so that the sender, receiver, title, and contents can be discerned from each other. This labeling is done with the help of so called tags which, in XML, always consist of a beginning and an ending part, and are encased in angle brackets. The entirety of beginning tag, enclosed content, and ending tag is called an element and is the basic building unit in XML. For example, the 'to' element `<to>Mario</to>` specifies the receiver of the note, Mario.

Because of the extensible nature of XML, the example in Listing 3.1 can easily be adapted to add or drop particular pieces of information as shown in Listing 3.2 on page 100. Here, the heading element has been removed while date and hour elements have been inserted.

Although this flexibility is one of the main properties and advantages of XML, it is sensible to specify a certain fixed structure for recurring use cases, a sort of template for what all notes, for instance, should look like. This can be done with the help of an XML Schema Definition (XSD) or a Document Type Definition (DTD), essentially text files

39. This does not mean, however, that there are no rules to XML. Just like any other (programming or markup) language, XML possesses a syntax that has to be followed in order to create well-formed documents.

```
<note>
  <date>2015-09-01</date>
  <hour>08:30</hour>
  <to>Mario</to>
  <from>Luigi</from>
  <body>Don't forget me this weekend!</body>
</note>
```

Listing 3.2: Edited version of Listing 3.1.

that specify what kind of tags are allowed (or even possibly required).[40] An XML file can then be validated against these default definitions to see if it fulfills the predefined setup.

This approach allows for different users to work in different workspaces, even at geographically different locations, and still produce output following the same structure. At the same time, this structure can—and has to—be defined by the users in the first place, enabling them to model the data they are working with as precisely and flexibly as possible.

In light of their task to equip various Academy projects with an environment for the work with prosopographical data, the PDR team also developed a specific XML schema definition. The current data model revolves around three object types—person, aspect, and reference—and hence provides a distinct template for each of them.[41] Falling back to the visual of the pin board from the beginning of this subsection, the person object contains the properties of the pin board, the aspect object contains the properties of a pin, and the reference object contains the properties of the source of a pin (in other words, the bibliographical information).

Out of these three object types, the aspect object is the most interesting since it defines the form and structure of any particular biographical information within the infrastructure. As such, its standards are binding for all projects working with the PDR, but still regulate only the most fundamental issues. The finer details of the permissible markup are formulated in the so called classifications. These, in turn, are subject to the particular projects. Based on a default classification prepared by the PDR team, each research

40. Although both XSD and DTD serve the same purpose, they differ in particular details that are of no consequence for this work.

41. The object types specify which kind of objects can be created and used in the database. While the current model only knows of people, aspects, and references, the next version that the PDR team was working on towards the end of their runtime would have also allowed entities such as books. Such an extension of course could have been used to expand the JSN towards the bio-bibliographical collection as which it was initially intended.

project can define their own, adding and removing markup as needed.[42]

The application in which all the classification editing and data entry take place, the already mentioned PDR Archive Editor, furthermore enables the user to create a formalized input mask based on their classification. It is thus possible to build a template that only allows and/or even requires the entry of specific information, with the correct tagging inserted automatically in the background. Next to these templates, the user can still add information 'by hand', but have to choose and insert the proper markup themselves.

3.5. Data entry

Data entry in the Jesuit Science Network database is first and foremost a question of correctly identifying those members of the Society of Jesus who were active in the early modern sciences. With regard to sources such as Bogdan Lisiak's dictionary on Polish Jesuits in the exact sciences or Georg Schuppener's studies on Jesuit mathematics and mathematicians in Prague,[43] which by their title alone assure that all scholars treated are of interest for the JSN, this is an easy task; but concerning the DHCJ and especially the many densely packed volumes of the Sommervogel series, just opening the book and copying the information is not possible.

Fortunately, the tenth volume of the *Bibliothèque de la Compagnie de Jésus* offers a topical listing of the works collected in the prior nine volumes, compiled by the editor Pierre Bliard.[44] Figure 3.1 on page 103 shows pages XXIII and XXIV from the table of contents, containing the section on sciences and arts. From the part under "II. Sciences", "Sciences mathématiques", I have further chosen "Arithmétiques" for a closer look in Figure 3.2 on page 104.[45] A typical entry reads "De numero infinito, 1636. Der-Kennis Ign., II, 1943, 17",[46] which refers to the 1636 publication *De numero infinito* by Ignace Der-Kennis, the

42. In order to preserve comparability and keep the data structure similar over all projects, extensive changes or additions to the markup are discouraged. However, since the default classification was created collaboratively with the help of several Academy projects, it already offers suitable markup for most situations. In addition, the removal of markup is technically unnecessary because any user inputting data never comes in touch with the classification file itself, anyway.

43. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*; Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*; Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740*.

44. See the discussion in Section 2.3, especially Table 2.1 and page 66. As a reminder, this listing is what Steven Harris used as a basis for his statistical evaluations, see Section 2.4.2 and particularly Table 2.3 on page 76.

45. Sommervogel et al., *Bibliothèque de la Compagnie de Jésus*, volume X, p. XXIII.

46. Ibid., volume X, col. 816.

seventeenth item on his bibliography, found on column 1943 in volume II. For practical use, a student assistant extracted the authors' names from this list and compiled them into eight files, one for each volume including its supplement.[47] These files then provide the basis for the actual data entry.[48]. Concerning the expected range of the Jesuit Science Network, a discussion of the number itself, and the contribution of other sources, see the subsequent section for a detailed discussion.

As a basic principle, Bliard's categorization encompasses all Jesuit authors whose work titles touch upon topics from the early modern sciences, or in other words, all entries in Sommervogel whose bibliographies contain 'buzzwords' from the early modern sciences. The group so circumscribed is naturally of interest for the Jesuit Science Network, but since activity in the early modern sciences—the fundamental property the JSN is looking for—is not restricted to publishing works alone, it does not exhaust the *Bibliothèque*. It does, however, give rise to the following tripartition of entries in Sommervogel:[49]

1. Jesuit scholars with buzzwords in both their biography and bibliography
   An example would be Christoph Clavius, having taught mathematics (biographical buzzword) and published an edition of Euclid's Elements (bibliographical buzzword).[50] In my opinion, it is safe to assume that all Jesuit scholars with 'big names' in the early modern sciences belong here. This group is completely covered by Bliard's list.

2. Jesuit scholars with buzzwords only in their bibliography
   An example would be Ambroise Piganelli. He is cited as the author of a work on mechanics, the only available biographical data places him in the eighteenth century.[51] This group is also completely covered by Bliard's list. However, it comes with the large downside of not being easily searchable in the Jesuit Science Network, since group representatives have no buzzwords in their biographies and the JSN does not record the bibliographies.

3. Jesuit scholars with buzzwords only in their biography
   By its defining characteristic, this group is not covered by Bliard's list. As such,

47. I would like to extend thanks to Nadine Ogiolda for doing this work.
48. For a complete list of all the 950 names, see Appendix A.1.
49. The buzzwords are now based on the updated classification by Steven Harris, see Table 2.3.
50. The bibliographical buzzword is admittedly not 'Euclid's Elements', but geometry.
51. Sommervogel et al., *Bibliothèque de la Compagnie de Jésus*, volume VI, col. 745. In fact, the entry consists mostly of a remark how it is unclear whether Piganelli actually was a Jesuit or not, or even existed in the first place. This also makes Piganelli an example for some of the practical difficulties in working with Sommervogel.

col.

Vertus 529
Généralités, 529. — Vertus théologales, 532 ; charité envers le prochain, 533. — Autres vertus : chasteté, 534 ; conformité à la volonté divine ; emploi du temps ; humilité. 536 ; mortification. 537 ; obéissance ; patience et résignation, 538 ; pauvreté ; zèle, 542.

Péchés 542
Généralités, 542. — Diverses sortes de péchés, 545. — Conscience ; scrupules, 546. — Indulgences, 547. — Jubilé, 548. Commandements de Dieu, 549 ; de l'Eglise, 549.

Sacrements en général 549
Confirmation. 550. — Pénitence, 550 ; confession, 551 ; contrition. 553. — Eucharistie, 554. — Mariage, 564.

VII. THÉOLOGIE POLÉMIQUE.

Généralités et divers. 565

La vraie religion (Cf. infra, *Eglise catholique*) 580
L'Ecriture Sainte, 585.
Dieu, 587 ; S^te^ Trinité, 548. — Predestination, 589. — Péché, 589 — Purgatoire, 589. — Enfer ; Ciel, 590. — Jésus-Christ, 590. — S^te^ Vierge, 592. — Anges et Saints, 593. — Images et reliques, 594,
Grâce, 594. — Justification, 593. — Indulgences, 595. — Miracles. 596.
Eglise catholique (cf supra *Vraie religion*), 596. — Le Pape, 606
Sacrements en général, 611 — Baptême ; Pénitence, 611 — Eucharistie, 612, sainte messe, 615 ; communion, 616. — Extrême-Onction ; Ordre ; Mariage, 617.
Paganisme, 618. — Judaïsme, 620 — Mahométisme. 621. — Luthéranisme et Calvinisme, 621. — Anglicanisme, 645. — Jansénisme, 631. — Gallicanisme. 659. — Libéralisme, 660. — Schisme grec, 661. — Incrédulité, 662. — Franc-Maçonnerie, 664. — Erreurs diverses, 665. [cf. *Philosophes modernes*, col. 746.]

VIII. LITURGIE 671
Traités, cérémonies, 671 — Sainte Messe. 675. — Office divin, 676. — Fêtes, 681.

II. — JURISPRUDENCE

(*Col.* 683 *à* 714.)

DROIT ECCLÉSIASTIQUE, DROIT CIVIL.

Points communs et généralités 683
Droit civil. 685

col.

Droit ecclésiastique 687
Généralités, 687. — Points spéciaux, 689.
Canons, 694 ; Décrétales, 693 — Bulles et Constitutions, 696 — Concordats, 699.
Evêques, 699. — Clergé, 701. — Religieux. 701. — C^ie^ de Jésus : Institut, 705 ; privilèges, 709.
Sacrements, 710. — Biens ecclésiastiques, 712.

III. — SCIENCES, ARTS

(*Col.* 715 *à* 940.)

I. PHILOSOPHIE.

Généralités 715
Ouvrages généraux, 721. — Thèses, 726.
Philosophes anciens (études et commentaires) : Grecs, 733 ; Latins, 745 ; Chinois, 746. — Philosophes modernes : généralités, 746 ; auteurs, 747.

Dialectique et logique 750
Cours et thèses, 750. — Questions particulières, 754.

Métaphysique 755
Cours et généralités, 755. — Dieu, 762. — L'homme, généralités, 763 ; l'âme, 765. — Le Monde, 771. — Les Bêtes, 778.

Morale 779

Applications de la Morale 785
Economie politique et sociale, 785. — La question ouvrière, 787. — Questions diverses, politiques et sociales, 788.
La forme du gouvernement, et la manière de gouverner, 793. — Le Prince, 794. — Les Sujets, 795.
Pédagogie. 796. — Pédagogie et C^ie^ de Jésus. 803.
Commerce et industrie, 806.

II. SCIENCES.

Généralités, questions diverses 806

Sciences mathématiques 811
Généralités, 811. — Mathématiques, 813. — Arithmétique. 815. — Logarithmes, 819. — Algèbre fonctions, séries, 820. Analyse ; calcul différentiel et intégral. 821. — Géométrie : généralités, 823 ; sujets particuliers, 824. — Trigonométrie, 828. — Géométrie analytique, 830.

Mathématiques appliquées 830
Mécanique, 830. — Hydrostatique et hydraulique, 835. — Navigation, 837. — Art militaire, 838. — L'art de mesurer, 841. — Hydrographie, 842.

col.

Astronomie : généralités 845
Sujets particuliers, 846.

Astronomie pratique 851
Instruments, 851. — Observations, 853. — Calendriers, 854. — Gnomonique · cadrans, horloges, 857

Astronomie mathématique et astronomie physique 860
Sphère, 860. — Soleil, 861 (cf supra *Observations*). — Planctes : généralites, 866. — Planetes diverses (Jupiter, Mars, Mercure, Saturne, Terre, Vénus), 867. — Satellites, 870 ; la Lune, 871 (cf. supra *Observations*). — Etoiles, 875. — Comètes, 876. — Marées, 879.

Sciences physiques et chimiques.
Physique générale 880
Cours et traités d'ensemble, 880. — Sujets particuliers, 882.
Physique moléculaire. Air. fluides, 888 — Lumière, 889 ; optique, 890 — Acoustique, 894 — Chaleur, 895. — Pesanteur, 896. — Electricité et Magnétisme, 898

Météorologie et physique du globe. . . . 901
Sismologie, 907.

Chimie. 909

Sciences naturelles : généralités . . 910
Sciences médicales, 913. — Zoologie, 916 — Géologie, 919. — Minéralogie, 920. — Paléontologie, 921. — Botanique, 922. — Agriculture et Economie rurale, 925. Philosophie occulte, 927.

III. BEAUX-ARTS 929
Généralités, 929. — Peinture et dessin, 930 — Sculpture, 932. — Architecture, 932. — Musique : esthétique, histoire, théorie, 935 ; instruments, 937 ; œuvres musicales, 937. — Danse, 938. — Equitation, 938.
Arts appliqués, 939. — Ecriture, imprimerie, 939. — Mnémonique, 940.

IV. — BELLES-LETTRES

(*Col.* 941 *à* 1384.)

I. LINGUISTIQUE.

Généralités 941

Langues classiques. 943
Langue grecque : généralités, éléments, grammaires, 943. — Dictionnaires, 945. — Questions diverses, 946.
Langue latine : Éléments, grammaires, 947. — Dictionnaires, 951. — Questions diverses, 953

col.

Langues européennes : généralités . . . 957
Allemand, 957. — Anglais, 959. — Basque ; Bohémien ; Celtiques (langues), 939. — Croate, 960 — Espagnol, 960. — Etrusque, 961. — Français · grammaires, 961 ; dictionnaires, 962 ; questions diverses, 963. — Hollandais et flamand, 964. — Hongrois, 964 — Illyrien et wende, 965. — Italien : grammaires ; dictionnaires, 965, questions diverses, 966. — Polonais, dialectes slaves, 967. — Portugais, 969. — Provençal, Russe ; Turc, 969.

Langues asiatiques : généralités 970
Annamite, Siamois, Cochinchinois, 970. — Arabe, Arménien, Georgien. 971. — Chinois, 971. — Hébreu, 973 — Inde (langues de l'), 975. — Japonais, 976. — Persan, 976. — Sanscrit ; Syriaque, 976

Langues africaines 977
Angolais, Cafre. 977. — Egyptien, Ethiopien, Kabyle, 977. — Malgache, 978.

Langues américaines. 978
Amerique du Nord, 978 — Amérique centrale, 979. — Amérique méridionale. 980.

Langues océaniennes. 983

II. ÉLOQUENCE.

Introduction. 985
Traités généraux, exercices, exemples, 986. — Questions diverses, 988. — Etudes sur les modèles anciens : grecs, 991 ; latins, 992.

Œuvres oratoires 996
Recueils, 996. — Discours : sujets moraux, 998 ; sujets littéraires et scientifiques, 1004 ; sujets divers, 1011

Panégyriques profanes 1013
Eloges divers, compliments, 1013 à 1038. [*Ordre alphab. Cf. Sermons de circonstance, col.* 330 ; *poésies latines et profanes, col.* 1161.] — Groupes et anonymes, 1038

Eloges funèbres. 1067
Éloges funèbres : Jésuites, 1118. — Groupes, anonymes, recueils, 1120.

III. POÉSIE.

Généralités, préceptes, dictionnaires. . . 1123
Sujets divers, 1127.

Poésie grecque 1129
Poètes grecs (*ordre alphab.*), 1129. Compositions grecques, 1132.

Poésie latine 1134
Poètes latins : généralités, 1134. — Etudes et commentaires (*ordre alphab.*), 1134.
Compositions latines : sujets religieux, 1144 ; sujets profanes, 1161 à 1237.

Figure 3.1.: Two pages from the table of contents of the analytical index in volume X of the *Bibliothèque de la Compagnie de Jésus*, edited by Pierre Bliard. Source: Göttingen Digitisation Centre (CC BY 4.0).

440, 2. — 1782, *Scheffer Ch.*, VII, 772, 29. — 1759, *Schmidt Et.*, VII, 806, 1, 2. — 1772, *Schober Mart.*, VII, 841, 1. — 1661, *Schott Casp.*, VII, 907, 6. Cf. *Conrad Balt.*, II, 1372, 9; *Stromair Balt.*, IX, 863, 11. — 1638, *Schranast J.-B.*, VII, 944, A. — 1654, *Semple Hug.*, VII, 1117, A. — 1738, *Sicune, Coll. de*, VII, 1197, 11. — 1842, *Sinno J.-B de*, VII, 1232, 1. — 1719, *Spedalieri Mel.*, VII, 1421, 3. 1767, *Steinmeyer Ph.*, VII, 1543, 5. — 1634, *Stafford Ign.*, VII, 1472, 1, A; IX, 838, 2. — 1782, *Steindel F. X.*, VII, 1536, 2. — 1652, *Tacquet And.*, VII, 1806, 4, 7. — 1787, *Teixera Dom.*, VII, 1906, 1. — 1764-9, *Tessanech J.*, VII, 1946, 3, 7. — 1673, *Toulouse, Coll. de*, IX, 878, 47. — 1748, *Terreros Et.*, VII, 1934, 1. — 1685, *Thomas And.*, VII, 1977, 5. — 1753, *Touzin J. A.*, VIII, 196, B. — 162., *Tolentens J. G.*, VIII, 270, II. — 1634, *Tolet P.*, VIII, 336, A, B. — 1703, *Ulloa P.*, VIII, 343, 1. — 1760, *Unterrichter Jos.*, VIII, 346, 1. — 1716, *Vols Ern.*, VIII, 903, 5. — 17.., *Volpi Jos.*, VIII, 902, 30. — 1774, *Weinhart J.*, VIII, 1029, 5. — 1715, *Wonel Ch.*, VIII, 1205, 1. — 1773-84, *Wydra St.*, VIII, 1304, 1. — 1793, *Zallinger F. von*, VIII, 1445, 10, 13. — 167., *Zaragoza Jos.*, VIII, 1468, 0. — 1755, *Zebrowski Th.*, VIII, 1473, 3. — 1758, *Zugasti F. O.*, VIII, 1534, 1. — 1772, *Zumkley Casp.*, VIII, 1536, 4, 7, 8, 14, 16.

Alpha matheseos, 1733, (IX, 932)

Rudimenta mathematices ac geometriæ, (IX, 1294)

Arithmétique.

Theorema Fontenellianum dissertatione arithmetica expositum, 1772 *Agricola Jos.*, I, 77, 3.

Trigonarithmus ad proportionum regulam.., 1670 *Alias Vinc.*, I, 177, 1.

Première partie de l'arithmétique universelle, 1742. *André Yves*, I, 337, A.

Saggio tecnico.. metodo di eseguir i computi, 1782. *Arce Sim.*, I, 344, 1.

Maniera facile di servirsi del numero 11 nella prova della moltiplicazione e divisione, 1757. *Asclepi Jos. M.*, I, 600, 4.

Traité élémentaire d'arithmétique, 1844. *Aubert Ch.*, I, 615, 2. — Leçons d'arithmétique, 1851, (2).

Anleitung zur Rechenkunst, 1772 *Barth. Ant.*, I, 962, 3.

Arithmetica practica, 1660 *Behm G.*, I, 1130, 5.

Arithmetica practica, 1687 *Berzeliczi H.*, I, 1400, 3.

Aritmetica especulativa y practica, 1844. *Biel Jos.*, I, 1458, 1.

De proportione arithmetica, 1679. *Billy Jac de*, I, 1480, B.

Elementa de proportionibus, 1700. *Bologne, Coll. de*, I, 1677, 15.

Epitome arithmeticæ, 1600. *Borrasa Math.*, I, 1820, C.

Arithmeticæ epitome, 1604 *Brutscher J.*, II, 274, B.

Sur la numération des Romains, 1863. *Buck V. de*, II, 327, 71 *y*

Arithmetica, 1789. *Buil y Aznar Jos.*, II, 365, 1

Introductio ad arithmeticam, 1720. *Bystrzychi Mart.*, II, 479, 1.

De arithmetica, 178 *Camperver Ign.*, II, 605, 6

Les nombres et la philosophie, 1883. *Carbonnelle Ign.*, II, 727, 7.

Epitome arithmeticæ practicæ. 1583 *Clavius Christ.*, II, 1215, 4 Cf 15, 16

Arithmetica, 169 *Colet Guill.*, II, 1537, B.

Institutiones arithmeticæ, 1766 *Dubuis Fl.*, II, 1775, 2.

Beweiss, dass die in acht Procenten des Rohertrages ausgesprochene Grundsteuer gerecht sey, 1816. *Doetzl G.*, II, 1778, 16. — Erfindung einer neuen Rechensformel. 18.., (24)

De numero infinito, 1636 *Des-Kennes Ign.*, II, 1963, 17

Beautés des nombres, 1870. *Durand M.*, III, 299, G. — Sur le symbolisme des nombres, 1870, (1)

Aritmetica ragionata, 1881. *Egidi J.*, IX, 276, 1. — Teoria elementare delle quantità incommensurabili, 1893, (12) — Numeri il quadrato dei quali sta la somma di due quadrati, 1897. (14)

Rudimenta arithmeticæ, 1777 *Esseira P. L.*, III, 458, 1

Arithmetica practica, 1699. *Falchenberg A.*, III, 534, 1

Traité d'arithmétique et questionnaire, 1854-65 *Faton P.*, III, 553, 2-4.

Notabilia arithmetica, 1703 *Fischer Ant.*, III, 751, 1. — Bewois uber das lotto, 1784, (4).

Elementa arithmeticæ, 1646 *Fera Jac.*, III, 768, 1.

L'arithmétique, 1653. *Francois J.*, III, 938, 2 — De la quantité, 1655, (8).

Arithmetica, 1758 *Fuerlich Er.*, III, 1026, Q

Arithmetica introductio ad logisticam, 1676. *Gottignies G. F. de*, III, 1625, 7

Problema arithmeticum de rerum combinationibus, 1622. *Guldin P.*, III, 1946, 3 — Tabulæ numerorum quadratorum et cubicorum, 1635, (6).

Nova methodus arithmeticæ et algebræ, 1789. *Halley P. de*, IV, 56, C.

Specimen et dissertationes de rationibus duplicibus, 1771-3. *Heidfeld Ad.*, IV, 215, 1-3.

Libellus arithmeticus, 161.. *Hern Wolffg.*, IV, 223, 1.

Selecta elementorum matheseos, 1774. *Helfenzrieder J.*, IV, 234, 6, 10.

Varia compendia praxesque operationum arithmeticarum, 1755. *Heil Max.*, IV, 234, 4.

Arithmetica linearis, 1561. *Herbestus B.*, IV, 290, 10; IX, 473, 10.

Elementa arithmeticæ. 1753. *Hertl Ign.*, IV, 317, 1.

Aritmetica delle nazioni, 1786. *Hervas Laur.*, IV, 320, 2.

Compendium arithmeticæ. 1751. *Huberti Fr.*, IV, 496, 2.

Problema de censu post definitum annorum numerum expirante, 1772. *Jacobs J.*, IV, 711, 13.

De proportionibus, 1706 *Kirchner Melch.*, IV, 1080, 1.

Arithmetica y algebra, 1872. *Kolberg Jos.*, IX, 555, 4.

Methodus cujuscumque numeri non perfecte quadrati radicem determinandi, 1762. *Kraz G.*, IV, 1231, 3

Arithmetica Tyro-Brunensis, 1715. *Kresa Jac.*, IV, 1237, 3.

Arithmetica, 1635. *Kruger Osw.*, IV, 1260, 2

Institutiones arithmeticæ, 1646. *Lantz J.*, IV, 1496, 1.

Arithmetica Newtoni cum commentario, 1732. *Lecchi J. A.*, IV, 1633, 5.

Institutiones arithmeticæ, 1711. *Leone J. di*, IV, 1703, 1.

Arithmetica, 1660. *Leotaud Vinc.*, IV, 1706, 4.

Tabulæ memoriales arithmeticæ, 1746-1754. *Liesganig Jos.*, IV, 1823, 1, 3.

Eléments d'arithmétique, 1823. *Loriquet J. N.*, V, 11, 12.

Einleitung zur Rechenkunst, 1795. *Lusner Jos.*, V, 196, 1.

Introductio in arithmeticam et geometriam, 1674. *Lux Chr.*, V, 199, A.

Arithmetica, 1769. *Luxembourg, Coll. de*, V, 212, 3.

De arithmeticis et geometricis æquationum resolutionibus, 1770. *Mako P.*, V, 390, 10. — Institutiones arithmeticæ, 1777-8. (16).

Arithmetica practica, 1620. *Malapert Ch.*, V, 396, 3; IX, 631, 3. — Nova ratio dividendi per tabulam pythagoricam, 1620, (V, 396, 3).

Trattato di aritmetica, 1860. *Mancini Naz.*, V, 462, 1.

Demonstrationes mathematicæ de numero, 1716 *Martius Ign.*, V, 654, 1.

Scientia numerorum, 1702. *Mayer Chr.*, V, 795, 8.

Kurze Rechenkunst, 1788. *Mehler Chr.*, V, 871, 1.

Table des nombres simples et de tous les facteurs des nombres composés, 17... *Mercatelle ?*, V, 967 A.

Elementa arithmeticæ, 1769. *Mesburg G. von*, V. 1064, 2.

Arithmétique. 17.. *Mora Fel.*, V, 1274, 1.

Arithmetica, 1666. *Pajot Ch.*, VI, 93, 16.

Arithmetica, 1820. *Panizzoni Al.*, VI, 169, 6

Compendio de aritmetica y geometria, 18... *Perez y Campos*, VI, 528, E.

Arithmetica, 18. *Pinto Balt.*, IX, 772, D.

Arithmétique, 180. *Pons Jos.*, VI, 1002, C.

Trattato aritmetico, 1810. *Prat On.*, VI, 1174, I.

Arithmetica, 1797. *Rausch Fr.*, VI, 1492, 6.

De proportionibus, 1710. *Regalino J.-B.*, VI, 1582, 1.

Anleitung zur Rechnungskunst und Algebra, 1779. *Regelsperger Christ.*, VI, 1583, 20.

Elementa arithmeticæ, 1757. *Reuss G.*, VI, 1683, 1.

Arithmetica Neperiana, 163.. *Rho Jacq.*, VI, 1710, 19. — Explicatio regularum proportionum, 1630, (22).

Animadversiones in fractiones, 174.. *Riccati V.*, VI, 1774, 3.

Arithmetica practica, 159.. *Ricci Matth.*, VI, 1793, 4.

Trattati d'aritmetica ed algebra di Bezout, 1834. *Romano Jos.*, VII, 35, 3.

Eléments d'arithmétique, 1776. *Rossignol J.*, VII, 180, 4.

Elementi di aritmetica, 1840. *Rostagno J.-B.*, VII, 189, 1.

Aritmetica, 1894. *Salvado Et.*, IX, 833, 1.

Arithmeticæ elementa, 1750 *Sanvitale Fréd.*, VII, 601, 6. — Lettre sur la propriété des nombres, 1754, (9) — Compendiaria arithmeticæ et geometriæ elementa, 1756, (11).

Institutiones arithmeticæ, 1781. *Scherschmk Leop.*, VII, 773, 6.

Arithmetica practica, 1663. *Schott Gasp.*, VII, 909, 9.

De compositione et divisione numerorum, 1642. *Semple Hug.*, VII, 1117, 2.

Arytmetyka, 1766. *Siekierzynski Th.*, VII. 1492, 1.

Arithmetica methodice tradita, 1702. *Slaughter Et.*, VII, 1294, 4.

Anfangsgründe der Rechenkunst und Algebra, 1772 *Spengler J.*, VII, 1435, 1.

Universæ arithmeticæ elementa, 1761. *Spinelli Dom.*, VII, 1442, 2.

Institutiones arithmeticæ, 1782. *Steindel F. X.*, VII, 1536, 3.

Tirocinium arithmeticum, 1763. *Steinmeyer Phil.*, VII, 1543, 4.

Arithmetica, 1656 *Tacquet And.*, VII, 1840, 6.

Figure 3.2.: Detail from the analytical index in volume X of the *Bibliothèque de la Compagnie de Jésus*, edited by Pierre Bliard. Source: Göttingen Digitisation Centre (CC BY 4.0).

> it is also extremely underrepresented, if at all, within the Jesuit Science Network, and I cannot easily give an example. There is hence a dark figure of entries from Sommervogel that go unnoticed at this stage of development; however, a correction of this state is possible with the help of an automated search, see Section 5.4.

Another issue arises due to the fact that Bliard takes count of Jesuit dissertations. 'Dissertation' as a term and concept is again one of those things that denote something quite different today than in the early modern period, with the modern understanding only developing in the nineteenth century.[52] Initially, dissertations were published announcements for a student's oral exam and an introduction into its topic, usually written by the examiner who proposed the thesis or theses to be discussed. As such, dissertations had the purpose of publicly testifying to the knowledge, achievements, and performance of a university and its professors, which is why they were not to be composed by students.[53] With the written word gaining in esteem over the spoken, however, students began to have their name included as authors on their dissertations even despite not having authored them.[54]

The second group of Jesuits according to this tripartition, identified by buzzwords appearing only in their writings, hence could comprise scholars who were merely part of a board of examiners or students who simply had their name printed on their dissertations. These cases are cumbersome to identify since they require individual screening of the concerned dissertation, its contents, and possibly also other writings, and so I decided to include them in the JSN regardless of their certainty in order to err on the side of caution.

As for data entry itself, all work is manual so far.[55] It is thus prone to a range of very practical difficulties, the first and foremost being typographical, grammatical, and translation-related mistakes. Similar in nature are the minor inconsistencies that occur in choosing appropriate descriptions. While going through the list of occupations in the JSN, for example,[56] I found three different entries for basically the same thing: 'Director of an astronomical observatory', 'Director of observatory', and 'Director of the

52. Ulrich Rasche, "Die deutschen Universitäten und die ständische Gesellschaft", in *Bilder – Daten – Promotionen : Studien zum Promotionswesen an deutschen Universitäten der frühen Neuzeit*, ed. Rüdiger vom Bruch and Lorenz Friedrich Beck (Stuttgart: Franz Steiner Verlag, 2007), pp. 189.

53. Ibid., p. 190. It should also be pointed out that students had to pay for the dissertations themselves.

54. Ibid., pp. 190–191. During the remainder of the referenced section (until p. 201), Rasche continues to discuss early modern universitites allowing or prohibiting such a practice.

55. I would like to thank Dominic van Thuyl who entered the data from Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740* and Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*.

56. See `http://jesuitscience.net/occupations/`.

astronomical observatory'. Although the indefinite and definite articles denote slight differences in meaning and generally must not be equated with each other, the JSN is neither built to reflect these particular differences nor interested in them in the first place, so the best solution for this use case would be to pick one the three terms as the standard and change the others accordingly. Such inconsistencies are unfortunately not infrequent, but they pose only a minor annoyance as they can be fixed rather quickly. It generally takes some time during data entry until a firm vocabulary of descriptions and terms has been established; still, considering the amount of data involved in the JSN as well as the fact that some of these terms will only appear occasionally or even once, blunders are to be expected.

The other most important issue of data entry concerns the referencing of a piece of information given by multiple sources. Christoph Clavius' date of birth, for example, is provided both by Sommervogel, the DHCJ, and the VIAF. In order to keep the required amount of work during entry limited, I decided to only give one reference per piece of information, prioritize more modern sources to the *Bibliothèque*, and use the VIAF only second to literary sources. In the case of Clavius' date of birth, the DHCJ is hence given as its reference.[57]

While this approach still provides the user with all the available biographical data, it does take away a particular meta layer of information about the sources that would allow for their comparability and a quantitative evaluation. As such, a later inclusion of currently omitted sources is one of the tasks that I project for future work, see Section 5.4.

The above discussed diversity of occupation descriptions also extends to subject names. Remaining on the topic of astronomy, the JSN knows of 'Astronomical facilities', 'Astronomical instruments', 'Astronomical observations', 'Astronomical observatories', 'Astronomical observatory', 'Astronomical projects', and finally 'Astronomy' itself as areas of activity. In this case, however, a consolidation is not imperative and possibly not even advisable, since the sources name subjects with more accuracy and detail than they do occupations. This diversity also has the effect of 'expanding' Harris' classification from Table 2.3. The *what* search on the project website (see upcoming Section 3.7) hence uses the same subdivision, but contains more subjects; new additions are placed manually within this structure.

57. Please note that this procedure only holds for concurrences; differing information is always recorded properly with its respective sources.

3.6. Range and distribution

As I have explained above, the list assembled on the basis of the Bliard categorization contains the names of 950 individual Jesuits treated by Sommervogel who are credited with publications in the early modern sciences. This not only gives a first insight into the expectable range of the project, but also allows for a statistical evaluation of how the collected information is distributed across some select sources. Tables 3.3 and 3.4 on pages 108 and 109 shows all relevant numbers at one glance; I will explain the findings in the following.

The first thing to notice is that out of the 950 names on the Bliard list, 878 have been submitted to the Jesuit Science Network and 72 have been excluded, see Table 3.3. Unlike the uncertainty of dissertations discussed in the prior section, the 72 excluded scholars—all members of the second tripartition group, Jesuits with buzzwords only in the bibliographies—quite unmistakably do not seem to have any connection to the early modern sciences whatsoever. Were the JSN only to use information from the *Bibliothèque*, it would thus currently total 878 entries; for the sake of brevity and simplicity, I will refer to the these 878 names as the Bliard* list or just Bliard*.

But the JSN is not the only one relying on Bliard. Steven Harris similarly built his work on the categorization in Sommervogel's tenth volume—and, in stark contrast, reports of about 1600 Jesuit authors, both in his thesis and his later papers.[58] Unfortunately, due to a lack of further explanations and no list of names given at any time, I find this number very difficult to comprehend. While Harris does move around the categories used by Bliard to better fit his own classification of Jesuit science,[59] the way he does should not result in such an extreme difference.

At the same time, both the Bliard and Bliard* lists as well as their underlying categorization of Jesuit science depend on human understanding and interpretation, so that discrepancies between the works of different researchers are to expected. This poses one of the issues that would greatly benefit from the application of a search algorithm to an appropriately OCR-scanned version of the Sommervogel series, see Section 5.4. While it would not remove the human factor entirely and, in fact, would introduce uncertainties at other points (such as the choice of search terms), the criteria would have to be defined much more precisely, resulting in less gray areas. An automated search

58. Harris, "Les chaires de mathématiques", p. 248; Harris, "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition", pp. 30–31; Harris, "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773", pp. 18–19 and 139–140. See also Section 2.4.2.

59. See page 73.

	Bliard	Excluded	Bliard*
Names	950	72	878

Table 3.3.: Number of names on the Bliard and Bliard* lists.

would also prevent overlooking of suitable entries and reduce spelling mistakes.

The next numbers I would like to discuss concern the distribution of the collected information across some select sources, identifying the amount of overlapping and distinct names that each source supplies. The baseline is provided by Bliard*, and the other objects of comparison are the *Diccionario Histórico de la Compañía de Jesús* as the most comprehensive modern reference and the studies by Bogdan Lisiak and Georg Schuppener,[60] examples for regionally focused works whose range and content can still be comfortably managed.

The results presented in Table 3.4 show that the DHCJ contributes a total of 226 names, Lisiak a total of 36 names, and Schuppener a total of 53 names. The latter two numbers can easily be gleaned from the studies by counting the Jesuit scholars they cover; the first number is composed of names on the Bliard* list that are also treated in the DHCJ, and additional names that I found while looking through the four volumes by hand. Similarly to Lisiak, see page 92, the authors of the DHCJ assign labels such as misionero (missionary), escritor (writer), or astrónomo (astronomer) to the Jesuits they biograph. Also similarly to Lisiak, it is not explained how these labels are chosen; in addition, they unfortunately prove to be sufficient, yet not necessary.[61] Nonetheless, these labels allowed me to find another 16 distinct new names not given by Bliard* so far. As such, the overlap between the DHCJ and Bliard* amounts to 211 names.

Lisiak and Schuppener in turn each overlap with Bliard* with 22 names, among them two that they also share between themselves.[62] There are no further concurrences with the DHCJ or each other, though, so that Lisiak provides 14 and Schuppener 31 distinct new names for the Jesuit Science Network.

60. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*; Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*; Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740*.

61. As an example, Franz Storer (1617–1662), for whom teaching activity in mathematics is recorded, only carries the label misionero. Were his name not part of the Bliard* list, I would most likely not have picked him out. J. Correia-Afonso, "Storer, Franz", in *Diccionario Histórico de la Compañía de Jesús*, ed. Charles O'Neill et al., vol. IV (Madrid: Universidad Pontifica Comillas, 2001), col. 3644.

62. The Jesuits in question are Adam Adamandy Kochański (1631–1700) and Georg Schönberger (1596–1645). While both Lisiak and Schuppener give biographies for Kochański, the Polish study only references Schönberger in passing as the teacher of Jan Mikołaj Smogulecki (1610–1656).

	DHCJ	Lisiak	Schuppener
Names total	227	36	53
Overlapping with Bliard*	211	22	22
Overlapping among each other	DHCJ und Schuppener 1 (Jan Milan), rest 0		
Distinct new names	16	14	31

Table 3.4.: Distribution of names across Bliard*, the DHCJ, and the studies by Lisiak and Schuppener.

3.7. The project website jesuitscience.net

Up to now, I have dealt with the more conceptual aspects of the Jesuit Science Network, related to the historical research and its implementation. While absolutely essential, this part of my work remains mostly 'invisible' to the end user; instead, they come in touch with the project through the project website, the access point to the collected data.

It should be noted at this point that the launching of websites seems to have become a stereotypical feature of digital projects, and is expected by professionals and laypeople alike. While these expectations are not clearly formulated, let alone standardized, they are still not held without reason. Digital projects in the humanities often amount to digital editions, digitizations of source material, multimedia presentations surrounding particular topics, or digital prosopographical studies, and hence by their purpose alone cannot get around using the Internet. In addition, they often aim to make their methods and results available to a general public audience in the first place. Print media, and that includes online print, such as articles or books might be suited for a description of the material in question, but are rarely adequate to contain and present the material itself. And even where it might be feasible, it not necessarily has to be sensible; not much could be gained from just printing the bare contents of the JSN, for example.[63]

In the case of the Jesuit Science Network, the development of a project website is vital to the successful realization of the research interests and tasks defined at the beginning of Section 3.1. However, since this is not my area of expertise, I need to draw on an external professional and was fortunate enough to enlist the cooperation of software developer Lars Feyerabend. He not only brings along the necessary technical and programming

63. Unfortunately, as almost normative as websites have become for digital projects, as badly planned and understood they often still are. At times not even perceived as an equal part of the necessary technical infrastructure by the researchers themselves, the effort that goes into building—and maintaining!—a website that both adequately represents the project contents and is user-friendly, is often grossly underestimated. In to learn and understand more about the general importance of design, I highly recommend Don Norman, *The Design of Everyday Things*, Revised & Expanded Edition (Basic Books, 2013).

knowledge in order to take care of the setup of the JSN website, but also has a profound understanding of usability and interface design. As such, he not only ensures stable functionalities and the use of up-to-date technologies, but also designs and builds the site so that it best suits both the contents and user interaction.[64] To borrow an observation from Susan Brown et al.'s paper on bringing projects in digital scholarship to a conclusion, "[w]e know that users are very easily put off by frustration in the use of new resources or tools, so publishing components that are unstable or poorly integrated may have a seriously negative impact."[65]

For the remainder of the thesis, I will be using the website domain 'jesuitscience.net' interchangeably with 'website'.

3.7.1. Technical adaptations

As I have explained earlier in Section 3.4, all the data collected for the Jesuit Science Network is first stored offline and locally in XML form and then synchronized with an online repository located on the servers of the Berlin-Brandenburg Academy of Sciences and Humanities. Once on this server, the data can be queried via an API courtesy of the PDR, and the output displayed on the respective project's website.[66]

While this method is mostly tried and trusted, there are a couple of good reasons for the JSN to take a different path. This is done by inserting an additional SQL database into the process and importing the project data from the PDR repository into it.[67] The SQL database is running on the same rented server space also hosting the website, and its use has the following benefits:

- Importing the data essentially results in a backup copy in an entirely different location, providing further security.
- Being independent from the Academy server and any of its possible downtimes further increases data availability.[68]

64. Lars Feyerabend's assistance with this project concerns exclusively the implementation and short-term maintenance of the website. He plays a corrective role in relation to my requirements, concepts, and wishes, and realizes them depending on their technical feasibility, but the ultimate decision making concerning all aspects lays entirely with me. Other than that, he does not contribute to my research or its writing down in this thesis.
For further contact information, go to `http://lars-feyerabend.de/`.

65. Susan Brown et al., "Published Yet Never Done: The Tension Between Projection and Completion in Digital Humanities Research", *DHQ: Digital Humanities Quarterly* (2009): paragraph 12.

66. The PDR provides functionalities to access the data, but each project is responsible to set up a frontend itself.

67. SQL is a language designed for managing data within relational database management systems.

68. There is no guarantee, of course, that the paid server has no downtime, but as it is a paid service, it

- In addition, the export makes the JSN somewhat independent of the PDR, as problems with the data can also be solved within the SQL database. However, this should only be treated as a temporary solution until the actual data can be corrected.
- From the practical point of view of designing the website and implementing the desired functionalities, XML is not the best format in terms of efficiency and processing speed, while SQL is highly optimized for this use case.
- In the same vein, having the database and the website code run on the same server (or the same server farm) allows for a more efficient communication between the two, and thus for a faster access time.

Importing the JSN data from the Person Data Repository into the SQL database does not change the original workflow, nor does it make the PDR superfluous in any way; the Archive Editor still is the one tool to enter and edit all data, and the repository on the Academy server still is the main storage point of the collected information. However, inserting the SQL database into the entire process serves towards the independence and technical optimization of the project. It allows to streamline both the data and the queries, and adapt them to the imposed requirements. It also helps realize the best practices of software engineering and thus enhances the worth of the Jesuit Science Network from the point of view of Digital Humanities.

3.7.2. Reaching the audience

Having to think of the intended end user is one facet of digital work that is rather foreign to the 'traditional' humanities. There, academic research usually results in the presentation of the reached conclusions in some written or oral form, and within a specific context that allows to identify and describe the expected audience quite precisely—the readers of a particular journal, for example, or the attendees at a particular conference. With the Jesuit Science Network, whose raison d'être partially arises from its goal to provide a service, the intended audience exceeds the confines of meetings and publications, and there is no specific context in which it has to fit; any person with access to the Internet who thinks of looking for information about the Jesuits can find the JSN. However, while dealing with an intended user base instead of an intended audience, this user base still can (and has to) be described, as it has ramifications for the development of the website of which it has to be made aware in the end.

will be easier to have things fixed.

First, the user base itself. Aside from historians of science and researchers studying the Jesuits in particular or religious orders in general, the Jesuit Science Network also wants to appeal to non-specialist historians, researchers in the Digital Humanities, and generally interested laypeople. As such, the site has to offer easy entry points for browsing the data as well as more detailed search functionalities so that users both with and without a specific background and interest can access the depth of information they require.

That means, second, that the website design has to be easily accessible, yet provide optional complex features. This encompasses the option to browse the collected data and look at a randomly chosen entry, the option to search the collected data for person, subject, place, and time (the *who*, *what*, *where*, and *when* introduced at the beginning of Section 3.1), the option to finetune the results of this search, and the integration of or linking to additional information from other sources.[69] To help with the search and visualization of geographical aspects, a mapping tool is needed, as well.

And third, making the JSN known. As usual, specialists on related topics can be reached by presenting the Jesuit Science Network on respective conferences and workshops,[70] additionally counting on a further spread by word-of-mouth advertising. However, neither is it possible to reach all the specialists this way, nor are interested laypeople included. One answer to this problem is inherent to the fact that the Jesuit Science Network is part of the medium Internet. Publicizing it hence translates to spreading it on related social media[71] as well as ensuring a good placement in the result pages of search engines. The latter process is called search engine optimization, SEO, and has become an industry of its own.[72]

69. One example for this, the import of spelling variants from the VIAF, has already been discussed in section 3.3 on page 95.

70. In 2016, I have shown and talked about the website in its different stages of development in various contexts: Digital History of science, Digital History, mathematical biography, early modern history, and local Jesuit studies. In the latter case, half of the audience consisted of laypeople.

71. The use of social media for academic purposes has actually become quite a topic, see, for example Mark Carrigan, *Social Media for Academics* (Sage, 2016); Diane Rasmussen Neal, ed., *Social Media for Academics : A practical guide* (Oxford: Chandos Publishing, 2012).

72. Out of the plethora of blog posts, podcasts, and other forms of publications dealing with SEO, I found the following three references especially helpful: Rand Fishkin and Moz Staff, "The Beginner's Guide to SEO", Moz, 2015, accessed 09/26/2017; "Google Search Engine Optimization Starter Guide", Google. Licensed under Creative Commons Attribution 3.0, 2010, accessed 09/26/2017; and Brian Gardner, Lauren Mancke, and Rebecca Gill, "A Beginner's Guide to SEO that Works", Episode of the podcast rainmaker.fm, transcript available online, August 2016, accessed 09/26/2017. While these three were designed mostly with Google in mind, similar guides exist with a focus on Bing and Yahoo. An introduction geared towards academics specifically can be found in Patrick Lowenthal and Joanna Dunlap, "Intentional Web Presence: 10 SEO Strategies Every Academic Needs to Know", EDUCAUSEreview, published 05/06/2012, accessed 09/26/2017. Finally, there have also been some considerations towards optimizing scholarly literature for

Unfortunately, yet not surprisingly, this is the most neglected aspect of my work on the Jesuit Science Network; not only has it little to do with the research interest itself, it also requires specialized knowledge and continued maintenance that, in its depth, goes beyond the possibilities of this project. But even if the realm of what I can do is rather limited, there are a couple of basic steps that can be taken in order to enhance the online visibility of the JSN:

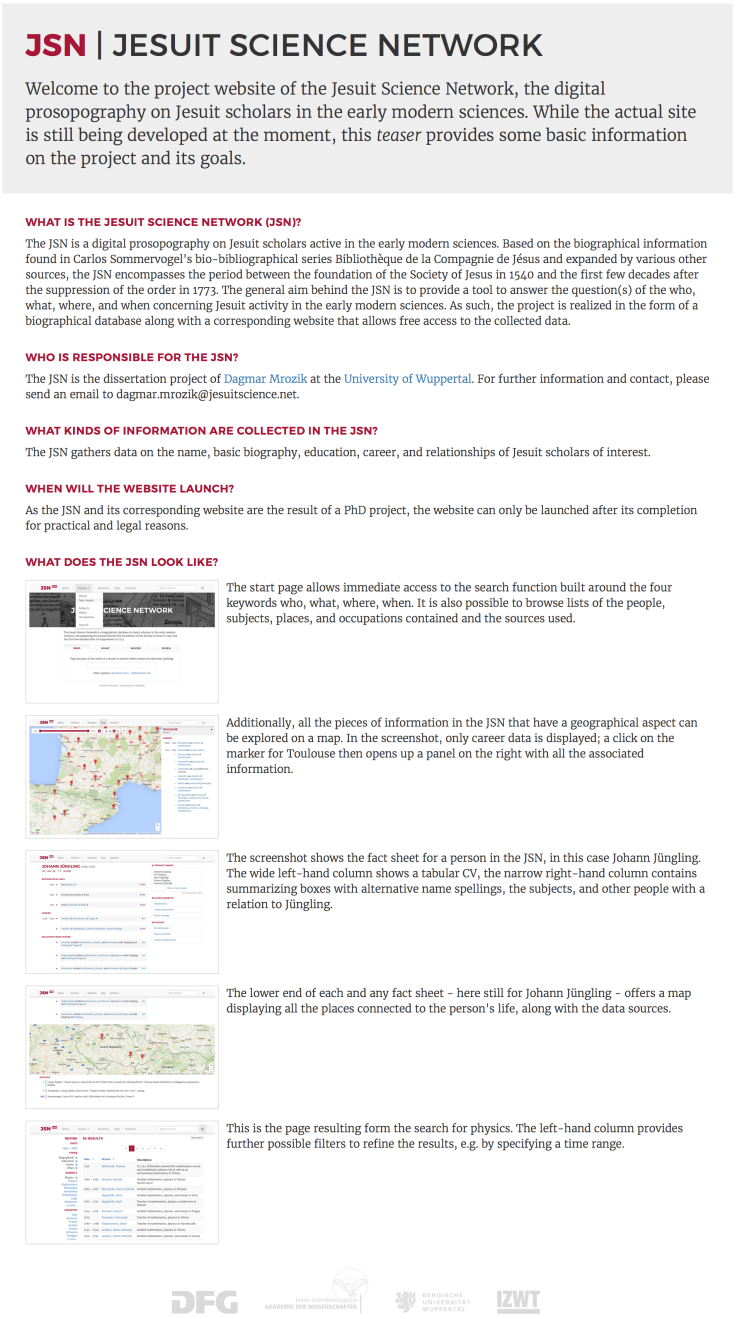
- Setting up a preview page.
  As soon as the domain jesuitscience.net was registered (and server space rented privately), a preview page was set up while the actual site was still under development. That way, the 'final home' of the project was established under its proper name, its address could already be handed out, some preliminary information about the JSN could be provided, and the domain was in use and accessible by search engines.[73] Growing along with the actual content, the preview went through several versions; the last one is shown in Figure 3.3 on page 114. It contains a short description of the aim of the JSN, contact information, and screenshots of some of the future functionalities along with relevant explanations.

- Following the fundamental rules of SEO.
  To be fair, there is most likely no actual set of fundamental rules that everybody dealing with SEO on a daily basis would agree on, but there are a couple of aspects that are regularly pointed out. Concerning the more technical work, the "Google Search Engine Optimization Starter Guide"[74] presents some best practices for choosing page titles, dealing with content in image form, and structuring URLs; all of these were also incorporated in the development of jesuitscience.net.
  Another important task is the choice of keywords. Keywords are quite literally words that describe and go well together with key aspects of a website's content; put in highly simplified terms, they are also what search engines collect and store about websites. In other words, choosing the 'correct' keywords means anticipating the search terms that might lead a potential user to the website; once established, they are then incorporated into site titles, meta descriptions, URLs, and the written

search engines, see Joeran Beel, Bela Gipp, and Erik Wilde, "Academic Search Engine Optimization (ASEO): Optimizing Scholarly Literature for Google Scholar and Co.", *Journal of Scholarly Publishing* 41, no. 2 (2010): pp. 176–190.

73. As of 11/11/2016, a search for the term 'Jesuit science' yielded the Jesuit Science Network as a result on page 4 of Google and page 1 on both Bing and DuckDuckGo. As of 09/20/2017, the same search yields the JSN on the first results page of all three engines.

74. "Google Search Engine Optimization Starter Guide".



JSN | JESUIT SCIENCE NETWORK

Welcome to the project website of the Jesuit Science Network, the digital prosopography on Jesuit scholars in the early modern sciences. While the actual site is still being developed at the moment, this *teaser* provides some basic information on the project and its goals.

WHAT IS THE JESUIT SCIENCE NETWORK (JSN)?

The JSN is a digital prosopography on Jesuit scholars active in the early modern sciences. Based on the biographical information found in Carlos Sommervogel's bio-bibliographical series Bibliothèque de la Compagnie de Jésus and expanded by various other sources, the JSN encompasses the period between the foundation of the Society of Jesus in 1540 and the first few decades after the suppression of the order in 1773. The general aim behind the JSN is to provide a tool to answer the question(s) of the who, what, where, and when concerning Jesuit activity in the early modern sciences. As such, the project is realized in the form of a biographical database along with a corresponding website that allows free access to the collected data.

WHO IS RESPONSIBLE FOR THE JSN?

The JSN is the dissertation project of Dagmar Mrozik at the University of Wuppertal. For further information and contact, please send an email to dagmar.mrozik@jesuitscience.net.

WHAT KINDS OF INFORMATION ARE COLLECTED IN THE JSN?

The JSN gathers data on the name, basic biography, education, career, and relationships of Jesuit scholars of interest.

WHEN WILL THE WEBSITE LAUNCH?

As the JSN and its corresponding website are the result of a PhD project, the website can only be launched after its completion for practical and legal reasons.

WHAT DOES THE JSN LOOK LIKE?

The start page allows immediate access to the search function built around the four keywords who, what, where, when. It is also possible to browse lists of the people, subjects, places, and occupations contained and the sources used.

Additionally, all the pieces of information in the JSN that have a geographical aspect can be explored on a map. In the screenshot, only career data is displayed; a click on the marker for Toulouse then opens up a panel on the right with all the associated information.

The screenshot shows the fact sheet for a person in the JSN, in this case Johann Jüngling. The wide left-hand column shows a tabular CV, the narrow right-hand column contains summarizing boxes with alternative name spellings, the subjects, and other people with a relation to Jüngling.

The lower end of each and any fact sheet – here still for Johann Jüngling – offers a map displaying all the places connected to the person's life, along with the data sources.

This is the page resulting form the search for physics. The left-hand column provides further possible filters to refine the results, e.g. by specifying a time range.

Figure 3.3.: Screenshot jesuitscience.net: Teaser page.

content, ideally in coherence with the actual content.[75] For the Jesuit Science Network, I defined the following keywords:

> Jesuit science, list of Jesuit scientists, Jesuit astronomy, famous Jesuits, Jesuit scholars, Society of Jesus, Societas Jesu, Societas Iesu, early modern period, early modern science, early modern sciences, history of science, history of mathematics, prosopography, Digital Humanities, Sommervogel, New Sommervogel Online

- Making use of newsletters and blogs to announce publication.
  By now, newsletters and scientific blogs have become established means of communication and information in the academic community.[76] Newsletters are used to distribute calls for paper, job listings, reviews, discussions, etc., and usually follow a self-defined netiquette, a code of conduct for its users. Depending on the kind of information that this netiquette allows to be shared, newsletters can thus be utilized to inform about the launching of project websites such as the one for the Jesuit Science Network. For example, the Belgian-run, English-language portal jesuitica.be[77] (based at the University of Leuven) maintains a weekly newsletter specialized on Jesuit studies that would allow to announce the publishing of the JSN. Other possibilities would be the English-language Mersenne newsletter, focused on the history, sociology and philosophy of science, technology and medicine,[78] the mostly German-language historical portal Clio Online maintaining a directory of online historical resources,[79] or the German/English-language his-

75. Rebecca Gill, SEO consultant, comments as follows on the changing practices in keyword research: "First, your point of the hidden keywords at the bottom and the meta keywords in the source code stuffed with just a bunch of words—I still encounter that every single week with prospects or clients. [...] There's still that philosophy that that's what works, but it doesn't. If you break down white hat SEO to this: to be successful in search you have to make the search engines happy. Let's take Google, for example. What is their goal? Their goal is to make money. They are a for-profit company. They sell ads, they have other products, but that's their goal. The only way they're going to do that is if they keep people happy. People come to the search engines, they search for something, they get good results that take them to a good website or blog that answers their question. If you veer off from that and you don't pay attention to the actual user and the visitor to your website and keeping them happy, you are not going to be successful with the search engines because you are not helping them be successful. That's white hat. It's focusing on your visitor. Writing content for the visitor. Making sure that it's fast, it got great performance, it's designed well so it's easier to read and the site flows. Keeping that visitor happy will make the search engines happy, because that visitor will come back to the search engines and use them again." Gardner, Mancke, and Gill, "A Beginner's Guide to SEO that Works".

76. On the subject of academic blogging in the historical sciences, see particularly the anthology by Peter Haber and Eva Pfanzelter, *historyblogosphere : Bloggen in den Geschichtswissenschaften* (München: Oldenbourg Verlag, 2013), pp. 37–49.

77. See `http://www.jesuitica.be`, accessed 11/10/2016.

78. See `http://www.jiscmail.ac.uk/lists/mersenne.html`, accessed 11/10/2016.

79. See `http://www.clio-online.de/`. The directory can be found under `http://www.clio-online.`

torical portal H-Soz-Kult.[80] Here, contributions have to follow a specific form and await approval by the editors before publication. Published entries are then also announced on the portal's own twitter account @hsozkult,[81] which is one example for how social media—in this case, the microblogging service Twitter—can be used to increase the visibility of academic content.
Another way to announce the publication of a finished project website is by blogging about it, of course ideally in a blog that already has a large audience. This type of advertisement is hence understandably more difficult to realize, as it either requires the project or its associated researchers to have a blog of their own, or for them to be acquainted with somebody else with such a blog willing to write about the launch. In this regard, it is certainly easier to spread the news via newsletter; on the other hand, blogs inherently offer a platform for discussion and exchange with their readers as well as linkback functions.

As I noted above, this has little to do with the historical research background of the project. But judging by how surprisingly difficult it can be to find the corresponding websites of research projects, even if the precise project name is at hand, by how often servers are moved and addresses changed or even deleted without providing a redirection, and by how complicated and long URLs can get, there is the very real danger of making one's work inaccessible by refusing to accept and deal with these issues. Further complicating the situation is the fact that databases and research websites are not included in the review sections of established journals. This entails negative consequences not only for the particular projects themselves, but also for Digital History and Digital Humanities in general. Since the projects receive no help in becoming visible to the community, the community cannot become accustomed to digital scholarship, and digital work cannot become an integrated, everyday aspect of research and teaching. As such, digital scholarship remains somewhat outside of the established standards of the discipline, a 'misfit' position that could potentially hamper the development and level of quality of digital work as well as deprive the analog faction of the community of fruitful impulses.

---

de/site/lang__de/40208087/default.aspx; new entries for the directory can be suggested by users under http://www.clio-online.de/urlmelden. All accessed 09/08/2017.

80. See http://www.hsozkult.de/, accessed 12/15/2016.

81. See https://twitter.com/hsozkult, accessed 11/10/2016.

3.7.3. Showcasing the Jesuit Science Network I: The website in screenshots

The overall Jesuit Science Network package is to be understood as one entity consisting of the historical background and the practical implementation in form of a structured database and an accompanying website. While Chapter 2 is dedicated to the historical context, this chapter is focused on the implementation; altogether, I have now completed the preliminary work necessary in order to proceed to the showcasing of the JSN, that is, a presentation of the actual tool available to the users of the project and of further evaluations based directly on the database itself. The showcase hence comprises two parts. The first one, following below, shows screenshots of the website accompanied by detailed commentary, aimed to provide an overall image and understanding of its contents and functionalities. The second part in Section 4.2 then deals with various analysis and visualizations of data restricted to one particular source, Bogdan Lisiak's study of Jesuits active in the early modern sciences on the grounds of the Polish-Lithuanian Commonwealth, and illustrates the possibilities and strengths of the chosen internal structure and data processing.

Both parts are central to a proper account on the Jesuit Science Network, inasmuch as they illuminate the opposing ends of a sliding scale concerning the accessibility of information within the project. On one end is the project SQL database, imported from the underlying PDR repository,[82] which mirrors the original information structure within the references quite closely. This leads to a high degree of complexity, data access is only possible via a particular query language, and any returned results are displayed in tabular form without any further formatting or visualization. At the same time, this allows for very detailed and sophisticated queries, for example the search for all Jesuits who were active in the early modern sciences after 1550 and born before 1700.[83]

On the other end of the scale is the JSN website and along with it, ease of use. The website was designed according to the objective of providing an easily accessible and usable tool for the exploration of data along the four basic questions of the *who*, *what*, *where*, and *when* of Jesuit science. This comes at the expense of a more restricted corset for both data and its display; as such, there is no full-text search available, for instance, and while search results may be filtered, it is not possible to conduct the same search as above with the website functionalities.

Because of that, the showcasing addresses both ends of the scale: first, the screenshots in Figures 3.4 to 3.14 on pages 119 to 130 and the subsequent commentaries and explana-

82. See Section 3.7.1.
83. This example is discussed within Section 5.5.

tions present the data contained in the Jesuit Science Network as it is available to any user; then, the evaluations in Section 4.2 focus on a more direct data query and access, including further processing in other applications, and give a glimpse into the greater potential inherent to such a digital prosopography.

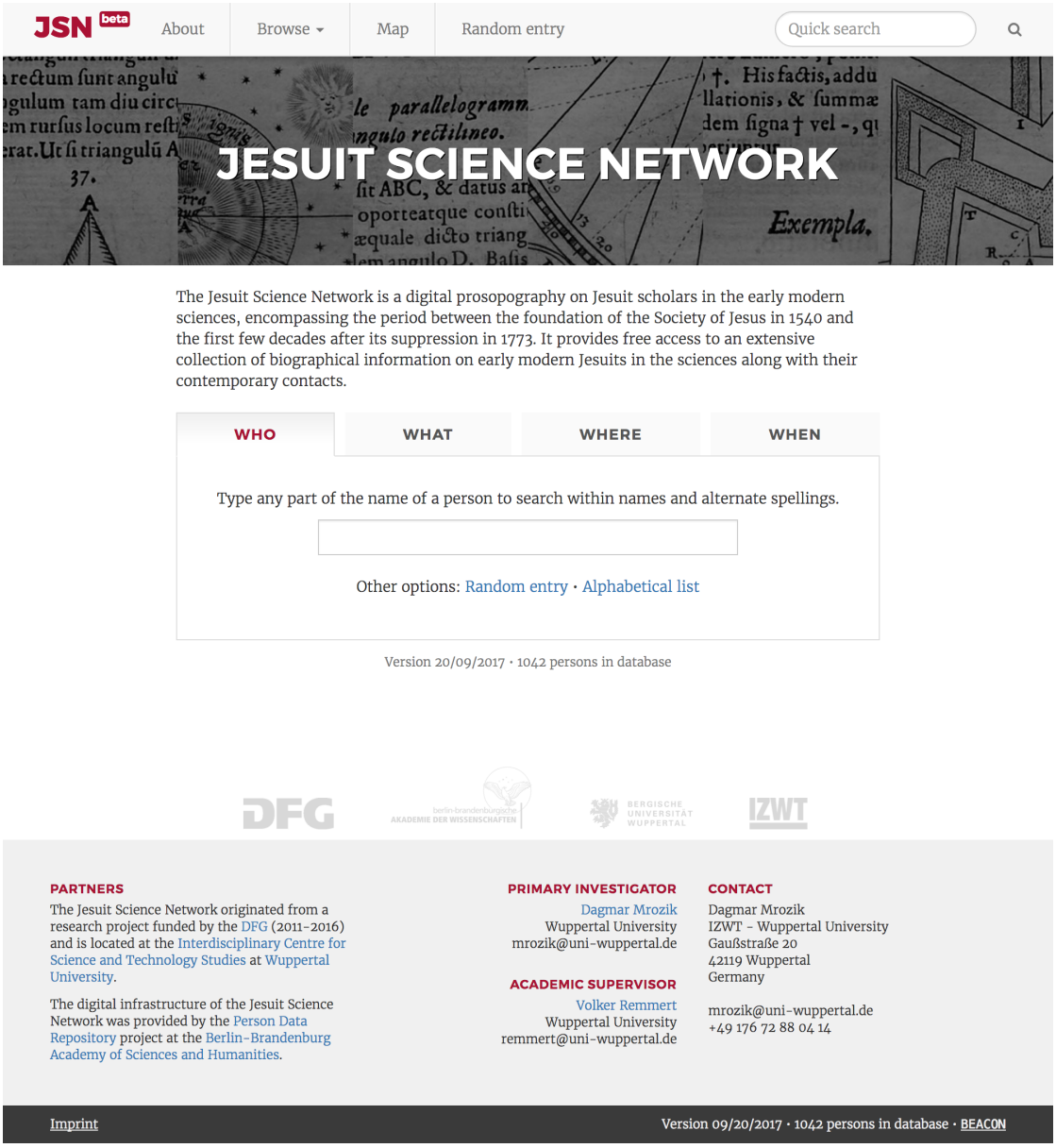
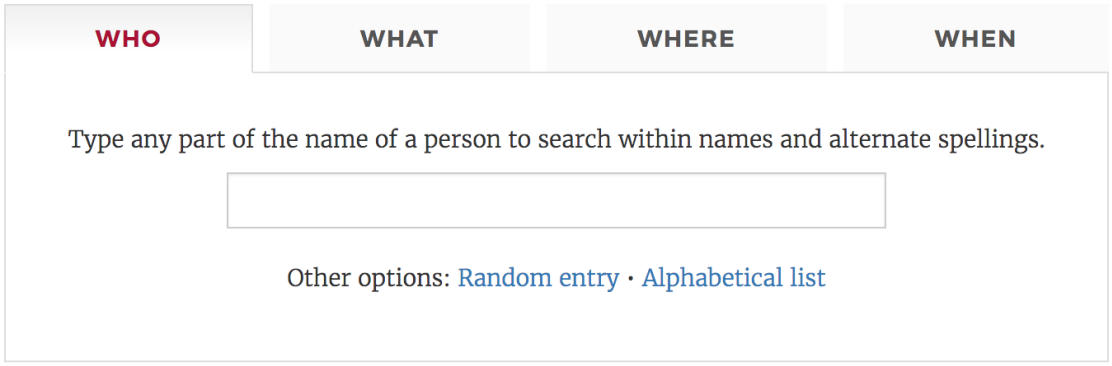
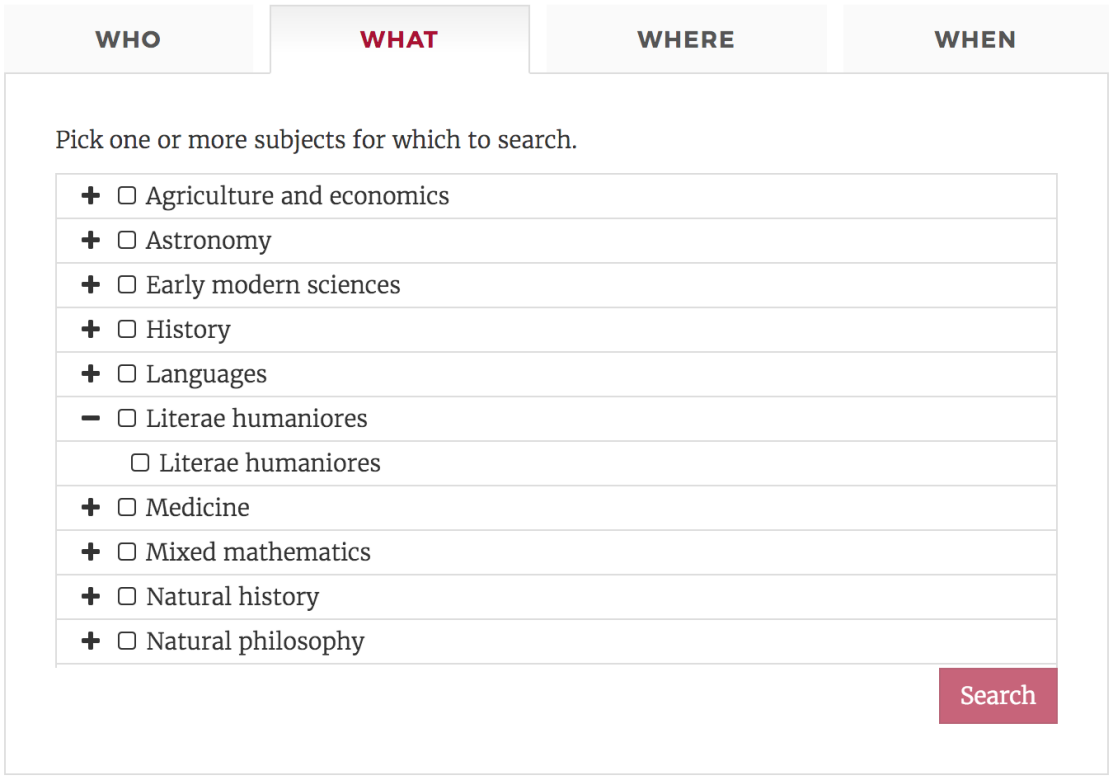


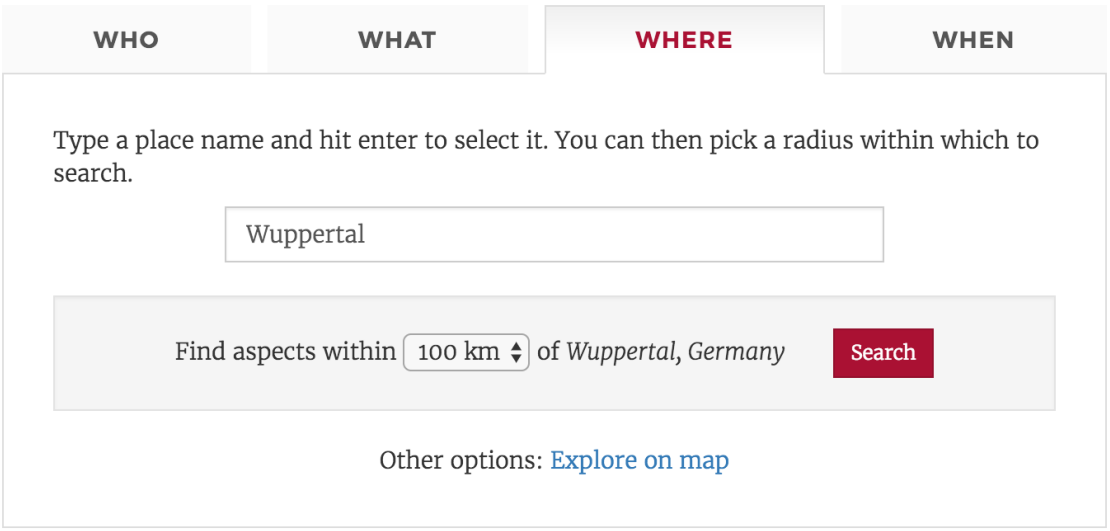
Figure 3.4.: Screenshot jesuitscience.net: Front page.


WHO
WHAT
WHERE
WHEN
Type any part of the name of a person to search within names and alternate spellings.
Other options: Random entry · Alphabetical list

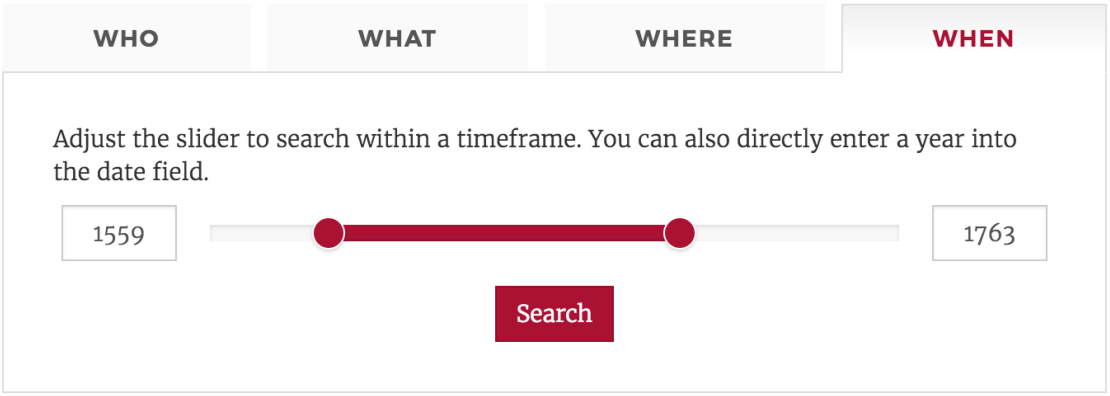
(a) Who


WHO
WHAT
WHERE
WHEN
Pick one or more subjects for which to search.
Agriculture and economics
Astronomy
Early modern sciences
History
Languages
Literae humaniores
Literae humaniores
Medicine
Mixed mathematics
Natural history
Natural philosophy
Search

(b) What



(c) Where



(d) When

Figure 3.5.: Screenshot jesuitscience.net: Search boxes.

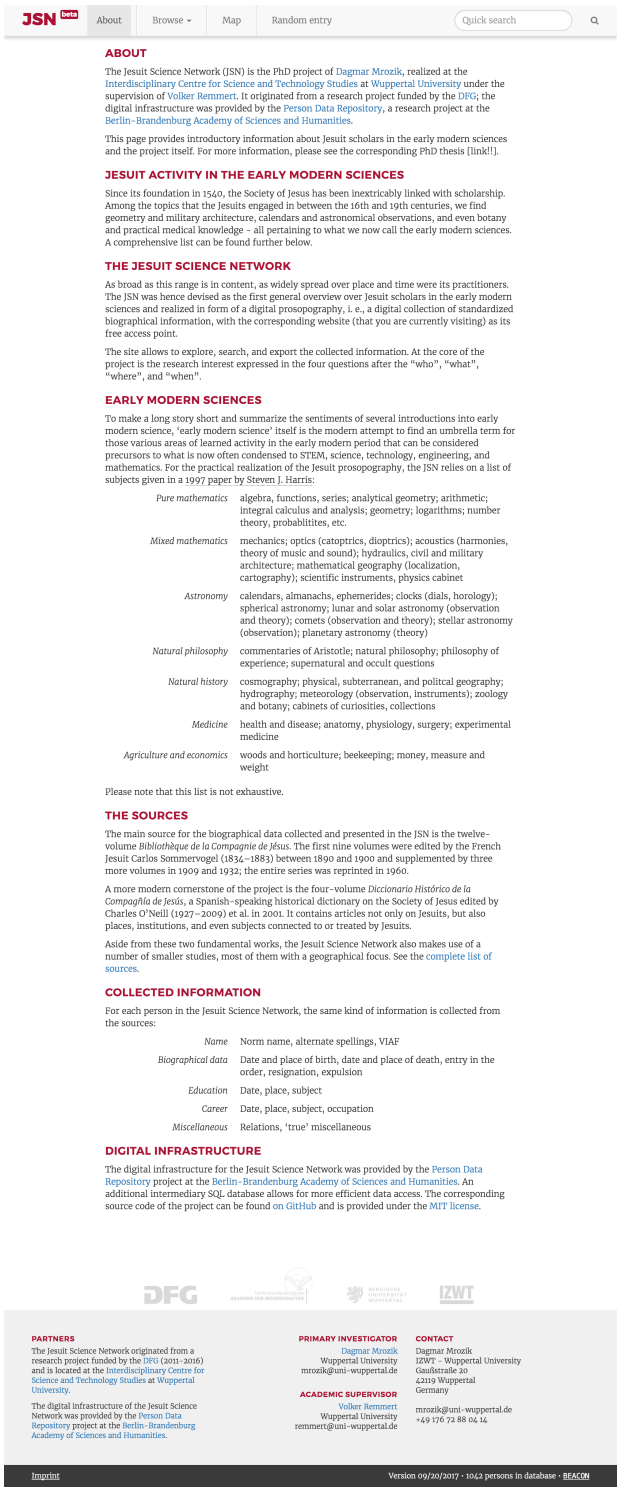


Figure 3.6.: Screenshot jesuitscience.net: About.

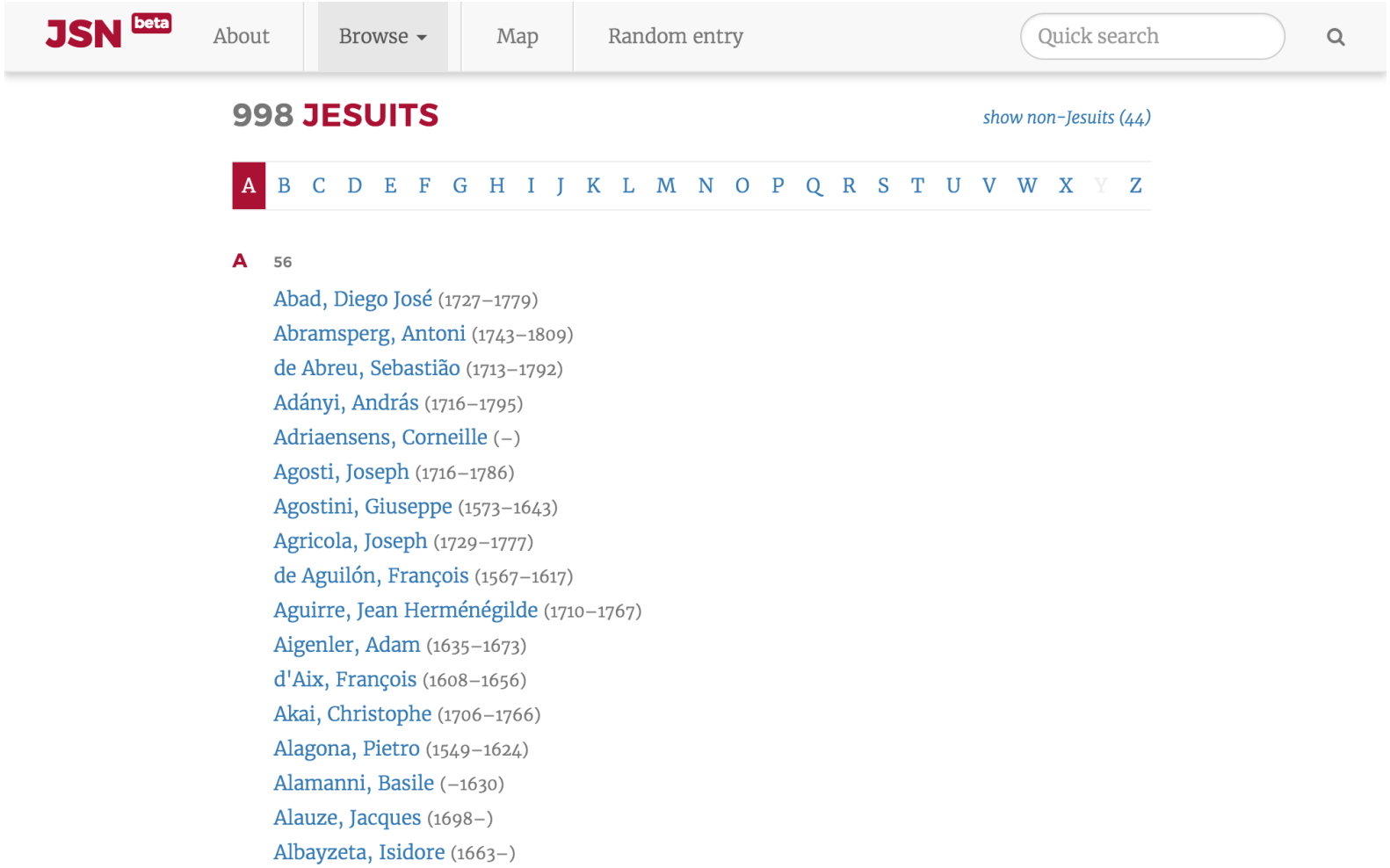


Figure 3.7.: Screenshot jesuitscience.net: Alphabetical list of Jesuits.

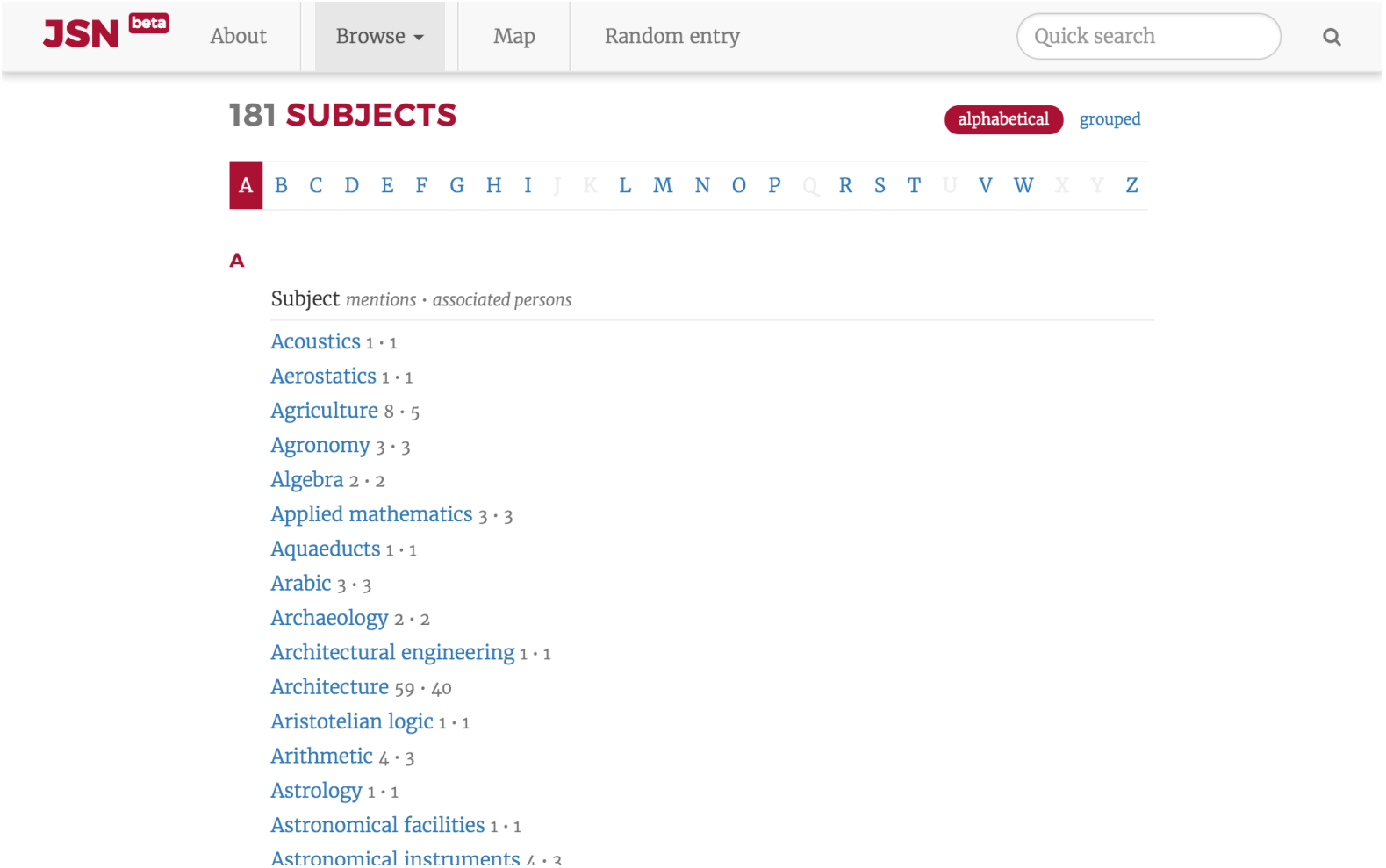


Figure 3.8.: Screenshot jesuitscience.net: Alphabetical list of subjects.

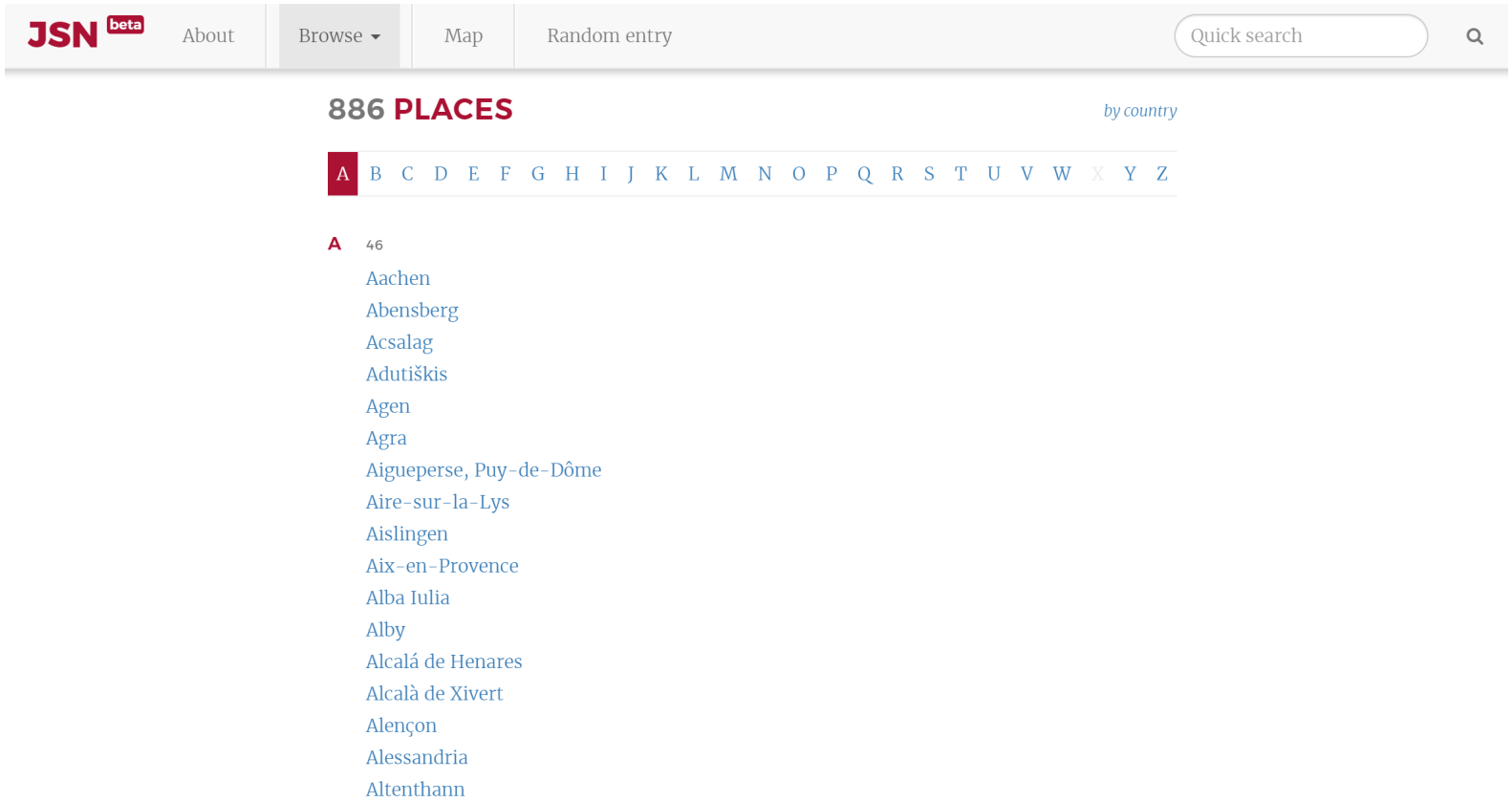


Figure 3.9.: Screenshot jesuitscience.net: Alphabetical list of places.

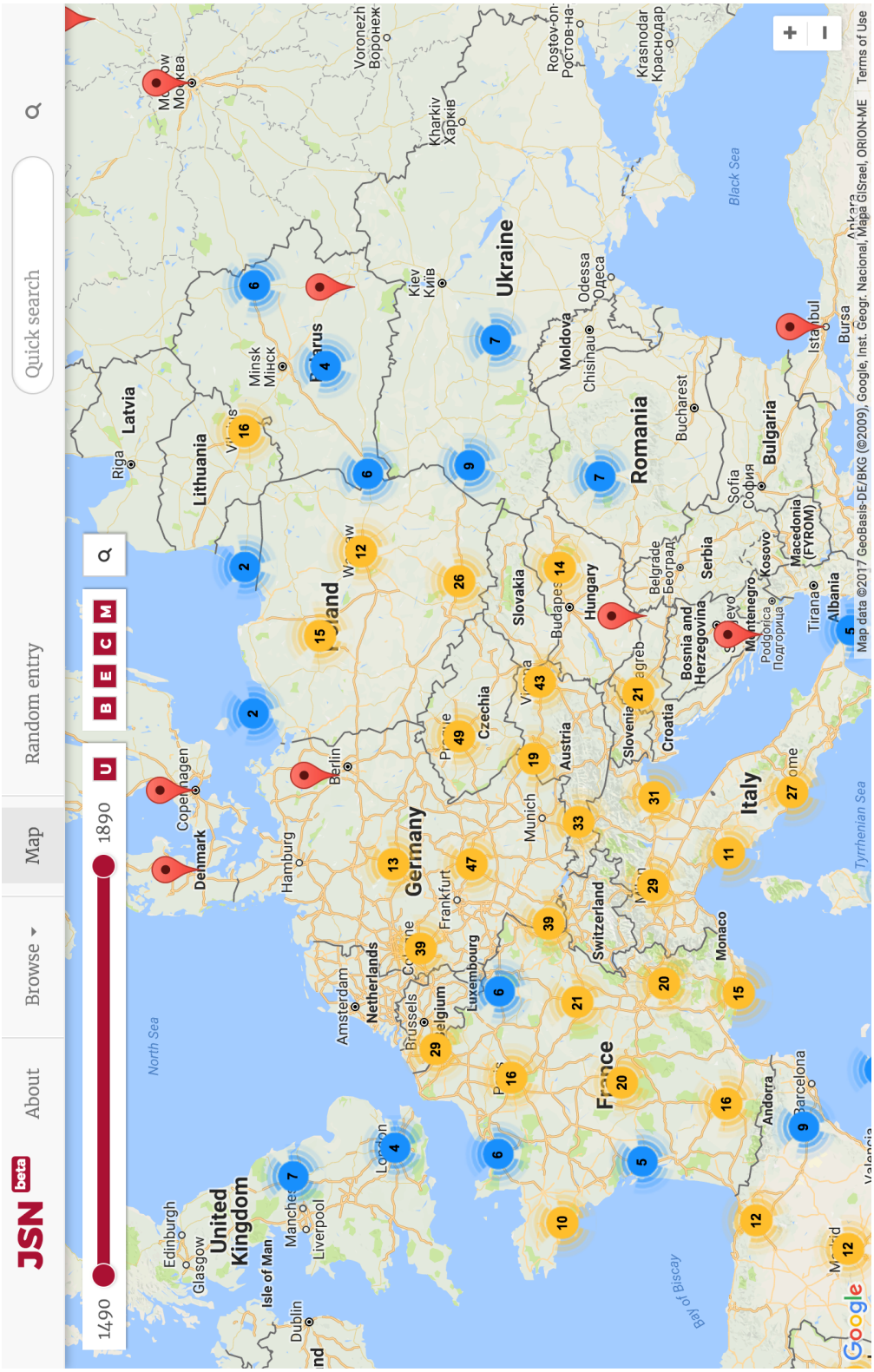


Figure 3.10.: Screenshot jesuitscience.net: Default map view.

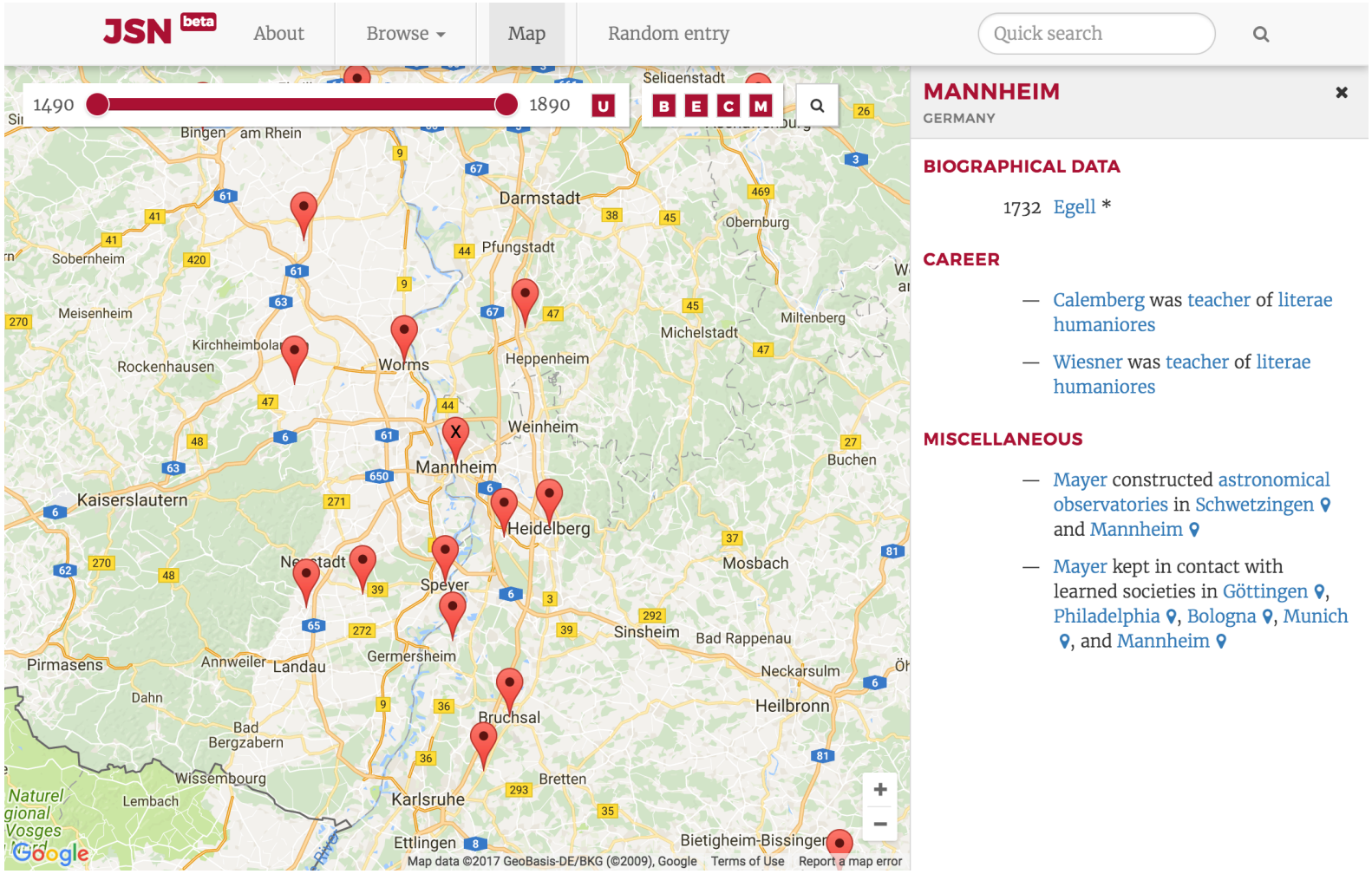
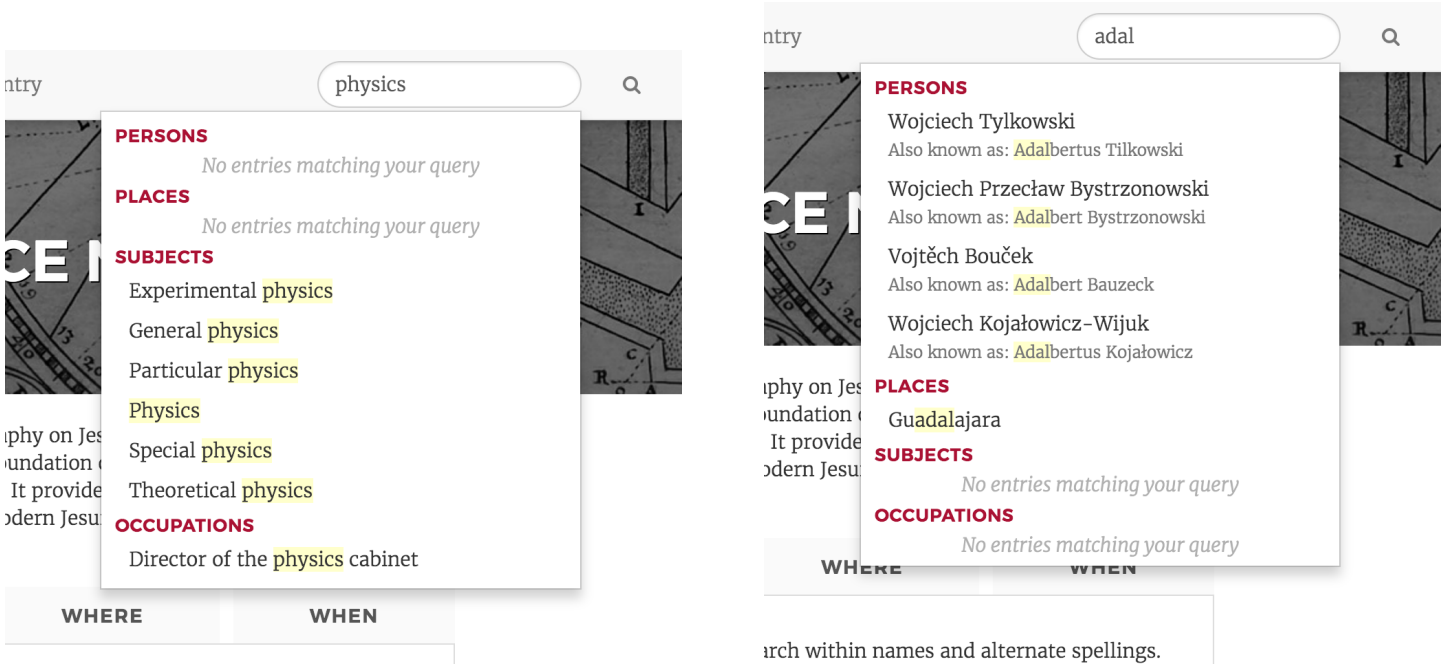


Figure 3.11.: Screenshot jesuitscience.net: Map view zoomed in.



(a) Search term 'physics'

(b) Search term 'adal'

Figure 3.12.: Screenshot jesuitscience.net: Quick search.

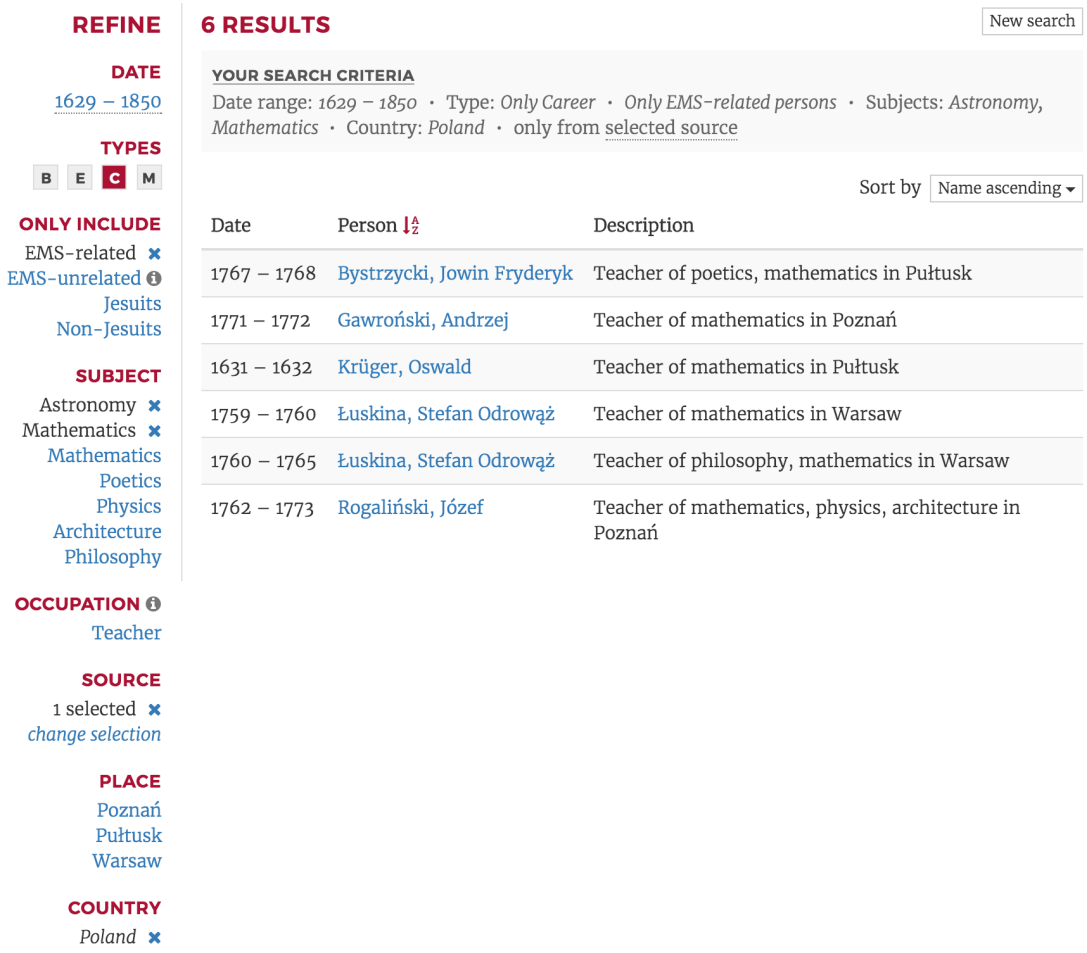


Figure 3.13.: Screenshot jesuitscience.net: Search results with filters.

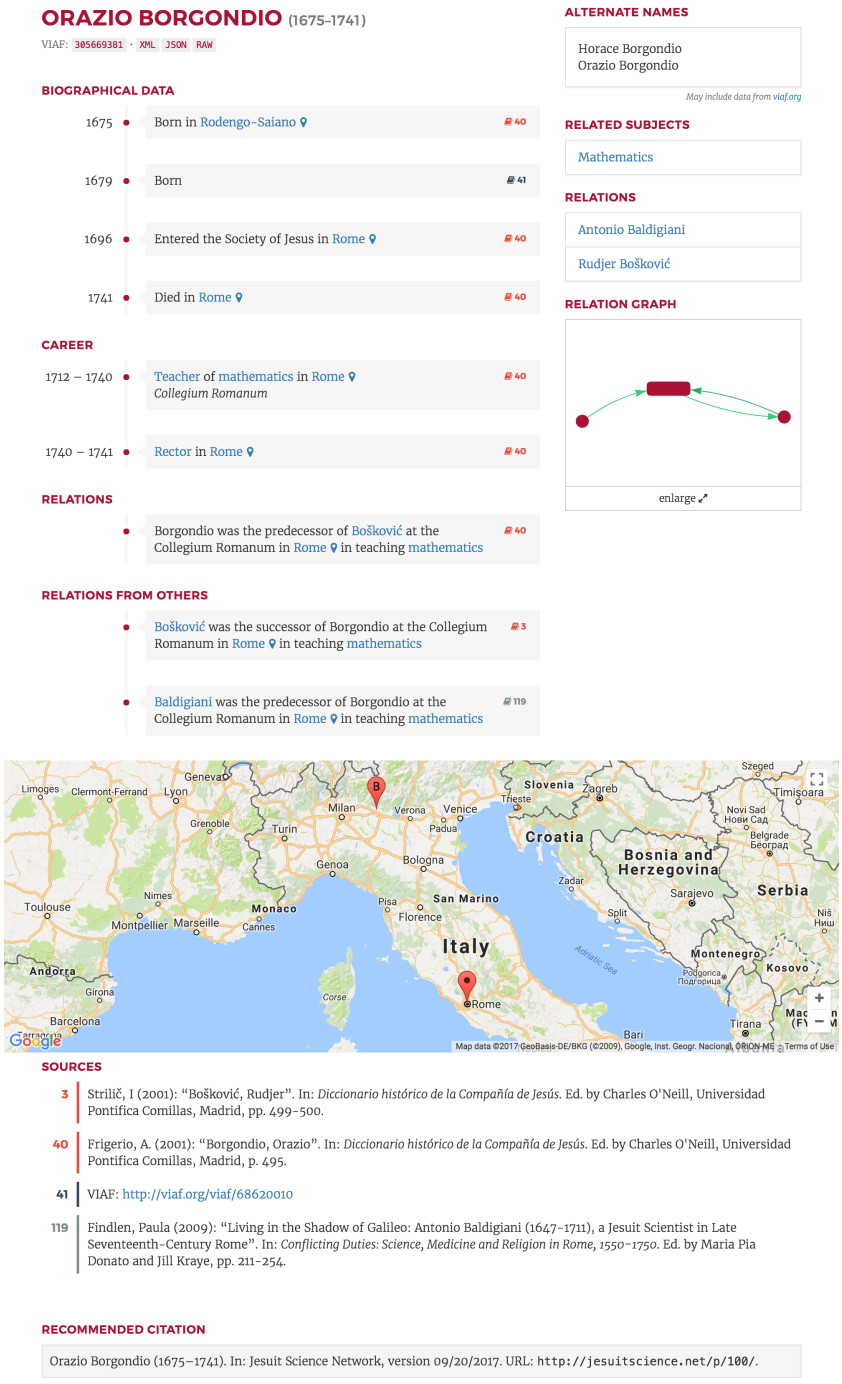


Figure 3.14.: Screenshot jesuitscience.net: Data sheet for Orazio Borgondio.

Figure 3.15.: Screenshot jesuitscience.net: Source annotation.

Front page

Figure 3.4 on page 119 begins with the front page of the Jesuit Science Network, the first page the user sees upon going to jesuitscience.net. The importance of the fundamental research interest of the JSN, the questions after the *who*, *what*, *where*, and *when* of Jesuit activity in the early modern sciences, is mirrored by the search boxes prominently featured here. This has two intended effects. First, it visibly reflects the concepts of the project and gives the user an idea of what to expect; and second, it offers an immediate entry point to the collected data, allowing the user to go medias in res. I find this particularly important in light of the many project websites, mainly built around the access to some kind of database, where the user first has to click through various subpages of context information before they get to the actual content. Of course a proper contextualization is very important for the JSN, as well, and is given on the About page (Figure 3.6 on page 122), but this must not be done at the expense of usability if users are supposed to return or even recommend the work.

The four main search boxes, shown in Figure 3.5 on page 121, function as follows:

who The name search considers both the norm name recorded in the database and the variants imported on-the-fly from the VIAF. Upon entering a string of letters, a pop-down appears listing all the potential matches. The user can then choose a name and go to the chosen person's data sheet; the data sheet is explained further ahead on page 137. If no matches exist for the string entered, this too is indicated in the pop-down.
The other two options offered are to go to the data sheet of a randomly selected person or look through an alphabetical list of all the persons covered by the JSN, shown in Figure 3.7 on page 123.

what The subject search allows the user to pick one or more subjects from a list containing all subject entries made to the database; the shown categorization follows Steven Harris's work (see Table 2.3 on page 76). Multiple subjects are connected by

an inclusive Or. After making a choice and clicking the Search button, the search is executed the user taken to the results page, discussed later ahead on page 134.
The other option is to look through an alphabetical list of all the subjects covered in the JSN, shown in Figure 3.8 on page 124.

where Upon typing the beginning of the name of a geographical location, a pop-down appears showing possible completions based on Google Maps data. The user can then select one of the results and indicate a perimeter within which the search is to be executed.[84] If the chosen result is a country or continent, exact matches from the JSN database are returned.
The other two options include open exploration on a screen-filling map view—this especially allows to use the visible map section as a search boundary, examined in detail on Section 3.7.3—and looking through a list of all the geographical locations appearing in the JSN, shown in Figure 3.9 on page 125.

when The time search allows to set a beginning and ending date, with both dates included in the search, and encompasses all dated aspects. The default values for the ending dates are derived automatically from the earliest and latest date to be found in the database.

Further refinements to all of these searches can be made directly on the results page.

While the search boxes provide a central functionality of the website, the menu is the central navigation hub from which the various parts of the website can be accessed. It is always visible and contains, from left to right, the following elements:

JSN links to the front page and thus to the main search.

About leads to an abridged description of the project context.

Browse opens a drop-down menu with the entries 'Jesuits', 'Non-Jesuits', 'Subjects', 'Places', 'Occupations', and 'Sources', each leading to the respective list. The first four have already been introduced as additional options given within the *who*, *what*, and *where* search boxes; 'Occupations' presents an alphabetically sorted listing of all the occupational descriptions[85] found in the database; and 'Sources' gives a collected bibliography of all the aspect sources referenced within the JSN.

Map leads to the map view.

84. I am told that this is a pretty sophisticated feature.
85. I have discussed the difficulties surrounding the use of the term occupation beginning on page 26.

Random entry leads to the data sheet of a randomly chosen person, allowing the user to easily and quickly explore the JSN contents without having to have a particular question in mind.

Quick search allows to search for persons, places, subjects, and occupations straight from the menu bar. It requires input by the user and offers matches within the database in a pop-down. If the user is looking for a person, typing (parts of) a name and selecting an entry on the pop-down will take them to this person's data sheet. If no matches exist for the string entered, this too is indicated in the pop-down. Section 3.7.3 on page 128 illustrates how the quick search works with the help of two examples.

Aside from the menu, there is one other part of the website that is visible on every page, namely the so called footer located at the very bottom. Its function is mainly to satisfy legal requirements by providing contact information and the imprint. In addition, it also contains a one-sentence description of the Jesuit Science Network incorporating some of the keywords relevant to SEO,[86] provides the date of the latest website version, shows how many persons are in the database, and links to the JSN BEACON file.

In general, BEACON is "a data interchange format for large numbers of uniform links".[87] It can be used by providers of online content who want to supply a catalog of their 'range of products' so that they can easily be linked to by others. In the case of personal data that can be tied to a unique identifier such as the VIAF or GND, the compilation of BEACON files allows research projects, libraries, and other academic institutions as content providers to easily establish connections between their content and thus further academic cooperation and topical exploration.[88] This use of the BEACON format is also currently one of its main applications.

The JSN BEACON file hence contains all the VIAF IDs of entries in the JSN that have one. It also informs of a particular URL that can be used to access these entries via their VIAF, providing a comfortable way for other projects to link to the JSN.[89]

86. According to the brochure "Das Impressum im Internet : Ein Leitfaden für die Anbieterkennzeichnung auf Websites", e-Commerce-Verbindungsstelle Deutschland, 2014, the imprint must contain the full name, home or office address, email address, and at least one other way of contact that does not rely on the Internet, in this case an office phone number, for the person responsible.

87. Jakob Voß and Mathias Schindler, "BEACON link dump format", July 2014, accessed 12/01/2016.

88. A list of various BEACON resources can be found at `https://datahub.io/dataset/pndbeacon` (accessed 12/01/2016). For a review of the use of BEACON in online publications, see Harald Lordick, "BEACON – ‚Leuchtfeuer' für Online-Publikationen", 2015, accessed 09/26/2017.

89. This URL has the form `http://jesuitscience.net/viaf/<viaf_id>`.

About

The subpage found under 'About' offers an introduction into the Jesuit Science Network. It covers the early modern sciences by way of Table 2.3 (Steven Harris' categorization of topics studied by the Jesuits, page 76), the information to be collected by way of Table 3.2 (model instance of the JSN on page 94), the sources used, and some words on the digital infrastructure. The 'About' page is a concise description of the project focusing on the bare essentials behind the JSN; for more in-depth information, it refers to this thesis.[90]

Result page

The results page as shown in Figure 3.13 on page 129 is certainly at the heart of the Jesuit Science Network. This is essentially where all the work comes together and the entire concept becomes visible and, what is more, usable.

The results page is bipartite. The wide column on the right displays the results themselves, the particular aspects matching the search term, while the narrower column on the left allows for further refinement. By default, the results column shows the aspects in the same order in which the query returns them, but it is possible to order them by date (chronologically ascending/descending; undated aspects are shown first/last in that case) and the person they belong to (alphabetically ascending/descending by last name). The number of found results is displayed above the column along with the search and filter criteria and a link starting a new search.

In order to refine the search results, the user can apply a number of filters featured in the left-hand column.

Date The slider allows to set a beginning and ending date, with both dates included.

Types Following the categories used in the PDR data model,[91] the user can choose to only show aspects that belong to the basic biography, education, career, or miscellaneous category, or any number of combinations between them.

Only include The user can toggle to show only aspects from people associated with subjects from the early modern sciences, only aspects from people without any association to subjects from the early modern sciences, only Jesuits, or only non-Jesuits. The first and latter two are mutually exclusive among themselves, but can be combined with each other.

90. The entirety of the text can be found in Appendix B.3.
91. See Section 3.4 beginning on page 96.

Subject The subject filter allows to further narrow down the aspects in the results column with regard to the subjects they contain. When two or more subjects are chosen, the result shows only aspects from people who are associated with both subjects in their aspects (although not necessarily in one and the same aspect).

Occupation As discussed earlier beginning on page 26, choosing occupations for Jesuit scholars in the early modern period is anachronistic, oversimplifying, and sometimes not even possible. That said (and kept in mind), this is still a category of not inconsiderable interest. It is thus possible to filter the results for any occupations they contain.

Source The user can choose to only show aspects from specific sources.

Place/Country/Continent Eventually, the Continent, Country, and Place filters allow a further geographical refinement according to modern-day national borders as provided by Google Maps.

Map view

The map—Figure 3.10 on page 126 shows the default view—allows to explore visualizations of all those aspects in the Jesuit Science Network that contain geographical information, about 70 percent. Table 3.5 on page 136 reveals that there are aspects with zero to seven associated places, albeit the vast majority, 67.8 percent, have only one.[92] Due to this excluding character and the already examined anachronistic nature of displaying historical geographical information with modern means, the map should be used deliberately.

The map itself is embedded from Google Maps. Street View, imagery, and satellite views are disabled as these features are not needed, but dragging and zooming work as usual. All the places that appear in JSN aspects are marked with the standard Google Maps marker; the more the map is zoomed out, the less space there is for the markers on screen so that they get clustered into colored circles. Clicking on one of these clusters zooms into in order to provide the respective area with more detail.

At this point I would like to call attention to the fact that being able to display these markers on the map is a direct result of the interjected SQL database. Since the original data in the PDR database does not have any geographical encoding, it is only during

92. Multiple associations occur when a person is reported to have performed the same activity at various places, and this information was then aggregated in one single aspect during data entry. Jesuit Jan Diesbach (1729–1792), for example, has the aspect "Teacher in Prague, Vienna, Olomouc, Brno".

Aspects	Associated places
1895	0
4564	1
184	2
65	3
8	4
8	5
3	6
4	7

Table 3.5.: Distribution of place associations among aspects.

the import from the PDR repository that place names are normalized and quipped with the necessary longitude and latitude. At times, a manual correction of the geocoding process is necessary—the Italian city of Naples, for example, was initially recognized as Naples, Long Beach, California by the Google algorithm.

By default, the map is centered on Europe and displays aspects of all categories. At its top, just under the menu bar, the user has the option to filter the displayed markers by specifying a time frame, toggle undated aspects, and toggle aspects from the Biography, Education, Career, and/or Miscellaneous categories. The magnifier icon at the end allows to use the visible map section as a geographical boundary for the search, and the fullscreen icon at the very right enables a fullscreen view.

Figure 3.11 on page 127 now further illustrates the functionality of the map. In this example, I have approximately zoomed in on the area of the Upper Rhine and clicked the marker for Mannheim, Germany, which triggered the pop-up column on the right-hand side of the map to appear. This column contains all the aspects associated with Mannheim; activating any of the filter toggles at the top of the map also affects what is shown here. Clicking on a name in the column leads to the respective person's data sheet, introduced in the subsequent section, while clicking on a place, subject, or occupation begins a search.

Finally, I would like to comment on the topic of historical maps. Aside from relying on modern mapping services such as Google Maps, Bing Maps, or OpenStreetMap, there is also the possibility of implementing a historical Geographic Information System (GIS).[93]

93. See, for example, Luís Espinha da Silveira, "Geographic Information Systems and Historical Research: An Appraisal", *International Journal of Humanities and Arts Computing* 8, no. 1 (2014): pp. 28–45, Ian N. Gregory and Paul S. Ell, *Historical GIS : Technologies, Methodologies and Scholarship* (Cambridge: Cambridge University Press, 2007), and Ian N. Gregory and Richard G. Healey, "Historical GIS: structuring, mapping and analysing geographies of the past", *Progress in Human Geography* 31, no. 5 (2007): pp. 638–653. A

However, due to the very broad scope of the Jesuit Science Network in terms of both area and time, it is near impossible to find appropriate historical maps for every map section at every point in time. On top of that, integrating a historical GIS would require a considerable programming effort and severely increase maintenance costs, so that Google Maps is the easiest solution for the time being.

Data sheet

On jesuitscience.net, all available information concerning a scholar recorded in the database is displayed on their so called data sheet, an enhanced online tabular CV. The data sheet is unique to each person and can be accessed via a permanent URL depending on the person's internal JSN ID (`http://jesuitscience.net/p/<jsn_id>`) or, if available, their VIAF (`http://jesuitscience.net/viaf/<viaf_id>`).[94] It shows not only the aspects from the JSN database and their respective references, but also imports additional information from other online sources and provides two visualizations on the basis of the JSN data. As an example, Figure 3.14 on page 130 shows the data sheet for Orazio Borgondio (1675–1741), which I will refer to in the following during my explanations.

The main part of the data sheet consists of two columns, a broader column with the aspects on the left and a narrower column with summarizing lists on the right. At the top of the sheet are Borgondio's norm name and his dates of life and death;[95] directly underneath is his VIAF. The links next to it allow to download the entirety of Borgondio's aspects in XML and JSON as seen on the website, which in particular includes the correct geocoding of all locations. This is not the case for the third download link that leads to the XML data as originally entered in the database.

The left column now contains all of the aspects pertaining to Borgondio and is presented in the structure of a simple tabular CV with the categories 'Biographical data', 'Education', 'Career', 'Miscellaneous', 'Relations', and 'Relations from others'. The distinction between the latter two stems from the way in which the PDR internally maps relationships, namely as directed relations between the originating and the target person.[96] This allows to model source information very precisely and minimizes the risk of misinterpretation and generalization, but it also requires more rigor and effort while en-

bibliography can also be found on `http://www.hgis.org.uk/bibliography.htm`, accessed 08/21/2017.

94. The VIAF-URL in particular comes to use in the Jesuit Science Network BEACON file, see page 133.

95. See page 94 for the reasoning behind the norm name, the standard version of a person's name.

96. Suppose it is known in the biography of A that A was teaching B, whereas the biography of B does not mention A at all. This relationship would then only be mapped as 'A taught B'; the logical inference 'B was taught by A' is only an inference, but not factual information given by the biographies.

tering data. Another PDR feature reflected on the website is the indication of a reference for every aspect. As can be seen in Figure 3.15 on page 131, every aspect has a little book icon and a number at its end; on hover, a small pop-up appears with the bibliographical information of the respective source, and on click, the view jumps down to the bottom of the page where the complete bibliography for this particular data sheet is put together.

The content of this left column partially reappears in the right column in a very condensed form. While the first box displays alternative spellings of Orazio Borgondio's name from VIAF,[97] the second and third boxes list all the subjects and scholars he is associated with in his aspects. The fourth and final box then contains a simple visualization of these relations, with an optional enlarged view in a separate browser window.

Further below the two columns and concluding the main part of the data sheet is a small map. It displays the locations appearing in the aspects and acts as a visual aid, helping to picture the often extensive traveling that being a Jesuit in the early modern period involved. In the case of Borgondio, however, this traveling only lead him to Rome.

Clicking on a location marker on the map produces a pop-up with the respective aspect contents. In turn, clicking on a small Google Maps-style marker in an aspect jumps the view from the aspect to the map below, with the corresponding location highlighted. Any other subjects, places, and names on the data sheet can be clicked, too, and lead to a search for the respective subject, place, or the data sheet for the respective person.

The final parts of the data sheet, underneath the map at its very bottom, are the collective bibliography mentioned earlier and a recommended citation. In the case of Borgondio, it reads: "Orazio Borgondio (1675–1741). In: Jesuit Science Network, version 09/20/2017. URL: `http://jesuitscience.net/p/100/`."

3.8. Legal considerations

To wrap up the discussion of the Jesuit Science Network and its accompanying project website, I would like to bring attention to a very important, yet often neglected aspect of digital work: the legal framework.[98]

97. The spellings are retrieved already during the import of the research data from the PDR repository into the JSN SQL database.

98. At this point, however, I need to set a disclaimer. I am no legal professional, and, while written to the best of my knowledge and understanding of the matter, this subsection must not be taken as proper legal counsel.

In general, 'traditional' research in the humanities results in the production of written text, be it in the form of a paper or a book. What is therein considered the proper scholarly conduct, namely the correct citation and attribution of content taken from other works, is at the same time the very specific legal mechanism that allows the use of copyrighted material in the first place. In German law, this mechanism is the so called Zitatrecht, the right to quotation. It is a part of the Schranken des Urheberrechts, limitations and exceptions to copyright, that have been installed to enable scholarly research and education, among others.[99]

While similar exceptions to copyright law have been installed within the legal frameworks in other countries, the problematic fact remains that they all have been conceived with traditional forms of publication in mind, most often based on print media.[100] Legislation has ever since struggled with adapting these laws to a more modern, or rather, to the contemporary state of media and publishing. An example of this can be found in the on-going difficulties and law suits concerning the practice of sampling in music,[101] but whereas at least some progress has been made in this regard, a desperately needed common framework for new forms of digital research is still in its very early stages of discussion.[102]

As such, researchers who employ digital methods and rely on digital forms of publica-

99. For an explanation, see Paul Klimpel and John H. Weitzmann, "Forschen in der digitalen Welt : Juristische Handreichung für die Geisteswissenschaften", GOEDOC, Dokumenten- und Publikationsserver der Georg-August-Universität Göttingen, 2015, p. 8, accessed 09/26/2017. The actual article is §51 UrhG. Further information, particularly including current discussions of the topic, can be found on the German website `https://irights.info/schlagwort/bildungs-und-wissenschaftsschranke`, accessed 08/21/2017.

100. Concerning digital publication practices in academia, see: Klaus Graf, "Dissertationsdruckzwang", published 08/18/2017, accessed 08/21/2017; Ben Kaden and Michael Kleineberg, "Zur Situation des digitalen geisteswissenschaftlichen Publizierens – Erfahrungen aus dem DFG-Projekt ‚Future Publications in den Humanities'", *Bibliothek Forschung und Praxis* 41, no. 1 (2017): pp. 7–14; Hubertus Kohle, "Digitales Publizieren", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), pp. 199–205; Peter Weingart and Niels Taubert, eds., *Wissenschaftliches Publizieren : Zwischen Digitalisierung, Leistungsmessung, Ökonomisierung und medialer Beobachtung* (Berlin/Boston: De Gruyter Akademie Forschung, 2016); Hamid R. Jamali, David Nicholas, and Eti Herman, "Scholarly reputation in the digital age and the role of emerging platforms and mechanisms", *Research Evaluation* 25, no. 1 (2016): pp. 37–49; Klaus Ceynowa and Lilian Landes, "Neuer Wein in neuen Schläuchen : Von Wissenschaftlern, die nicht nur anders publizieren, sondern auch anders schreiben werden", *Bibliothek Forschung und Praxis* 38, no. 2 (2014): pp. 287–293; Christine L. Borgman, *Scholarship in the Digital Age : Information, Infrastructure, and the Internet* (Cambridge, Massachusetts: MIT Press, 2007).

101. For an introduction into the culture, history, and legality of sampling, see, for example, Leonhard Dobusch and Valie Djordjevic, eds., *Generation Remix : Zwischen Popkultur und Kunst* (iRights.Media, 2014).

102. The already referenced Klimpel and Weitzmann, "Forschen in der digitalen Welt : Juristische Handreichung für die Geisteswissenschaften", offers a decent introduction into the legalese of this issue. In addition, Eric Steinhauer, "Recht", in *Digital Humanities : Eine Einführung*, ed. Fotis Jannidis, Hubertus Kohle, and Malte Rehbein (Stuttgart: J.B. Metzler, 2017), locates legal questions as an important area of study in the future of Digital Humanities (p. 351).

tion, particularly those that go beyond the publication of text, have to act within a certain legal insecurity as there are no definite legal guidelines available. Along with already existing copyright, this insecurity prevents me, too, from being able to publish all parts of the Jesuit Science Network—research data, source material, website source code, thesis, evaluations—equally under Open Access.[103] The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, as of now signed by official representatives of 595 governments, universities, research institutions, funding agencies, foundations, libraries, museums, archives, learned societies and professional associations, demands the following publication standards:

> "The author(s) and right holder(s) of such contributions grant(s) to all users a free, irrevocable, worldwide, right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship (community standards, will continue to provide the mechanism for enforcement of proper attribution and responsible use of the published work, as they do now), as well as the right to make small numbers of printed copies for their personal use."[104]

Ultimately, the only part of the JSN that I can guarantee Open Access to is the source code of the website. After completion of the doctoral procedure, it will be published under an MIT license on GitHub.[105]

103. See especially the recent collective volume by Konstanze Söllner and Bernhard Mittermaier, eds., *Praxishandbuch Open Access* (De Gruyter Saur, 2017).

104. "Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities", published 10/22/2003, accessed 09/26/2017.

105. The MIT license is a very permissible software license. It allows commercial use, modification, distribution, sublicensing, and private use of the original software, excludes the license giver from any liability concerning any derivations or copies of the original software, and requires the inclusion of a copyright and license notice in all derivations or copies of the original software. See `https://opensource.org/licenses/MIT`, accessed 09/24/2017.

Chapter 4.

Case study: Jesuit mathematicians in the Polish-Lithuanian Commonwealth

> "Despite the international scope of Jesuit education, all Jesuit history is local history, because the foundation and life of every single college and its school [...] was a complicated story involving many actors."[1]

All Jesuit history is local history; in keeping with this observation, over the course of the past chapters I have repeatedly pointed out particularities in the history of the Society of Jesus within the Polish-Lithuanian Commonwealth.[2] Similarly, Bogdan Lisiak's monograph *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, a bio-bibliographical account of Polish-Lithuanian Jesuits and their activities in the early modern sciences, has appeared many times. In the following, I will elaborate on both in the context of a case study focused on Jesuit mathematicians in the Commonwealth by first providing the necessary historical context and then presenting data-based evaluations on a sample taken from Lisiak, the continuation of the showcasing in Section 3.7.3.

There are two major reasons behind choosing this particular aspect of Jesuit history. Pertaining to the subject itself, it appears that Jesuit history in the Commonwealth is severely underrepresented in both English and German literature, but well studied in Polish scholarship. The most found author and editor in this regard is certainly Ludwik Grzebień, a Polish Jesuit historian working on the History of the Society in Poland. He

1. Grendler, "Jesuit Schools in Europe. A Historiographical Essay", p. 8.
2. For the sake of brevity, the terms Polish-Lithuanian Commonwealth, Commonwealth, and Poland-Lithuania will be used interchangeably for the reminder of the text.

edited a two-volume bibliography in 2009,[3] an encyclopedia on the Society in 2004,[4] and co-wrote the DHCJ entry on Poland,[5] the only non-Polish item in this introduction. There are also other bibliographies and encyclopedic works available.[6]

With regards to Jesuit schooling, in 2004, Grzebień also authored a bibliographical essay on the Jesuit contribution to the teaching and culture in the Commonwealth.[7] A similar 2003 essay by Jerzy Kochanowicz also features information on historical sources such as the records and catalogs kept by Jesuit colleges.[8] Finally, Irena Stasiewicz-Jasiukowa edited an extensive collective volume on Jesuit input to Polish education and culture in 2004.[9]

The other reason for this particular choice of case study is Lisiak's monograph itself, as it frankly seems to have been written with the Jesuit Science Network in mind. The *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny* is consistent in terms of both form and content, provides a rich collection of biographical information, reports often on personal relationships, and most of all features a manageable amount of scholars. But before I get to the details of the second showcasing in Section 4.2, I first want to set the appropriate scene and present some select aspects of Jesuit history in the Polish-Lithuanian Commonwealth.

4.1. Select aspects of Polish-Lithuanian Jesuit history

In the following, I would like to pick up the threads that I have variously spun in the first chapter of my thesis and trace an arc from the very beginnings of the Society of Jesus in the Polish-Lithuanian Commonwealth to its fate after the suppression in 1773. As many

3. Ludwik Grzebień, *Podstawowa bibliografia do dziejów Towarzystwa Jezusowego w Polsce*, vol. 1 (Kraków: Wydawnictwo WAM, 2009); Ludwik Grzebień, *Podstawowa bibliografia do dziejów Towarzystwa Jezusowego w Polsce*, vol. 2 (Kraków: Wydawnictwo WAM, 2009).

4. Ludwik Grzebień et al., eds., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995* (Kraków: Wydawnictwo NAM, 2004).

5. L. Grzebień and L. Piechnik, "Polonia", in *Diccionario histórico de la Compañía de Jesús*, ed. Charles O'Neill, vol. IV (Madrid: Universidad Pontifica Comillas, 2001), cols. 3173–3187.

6. See, for example: Andrzej Paweł Bieś, "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności", *Studia Pedagogica Ignatiana* 17 (2014): pp. 57–87; Felicjan Paluszkiewicz, *Mały słownik jezuitów w Polsce* (Warszawa: Bobolanum, 1995).

7. Ludwik Grzebień, "Dotychczasowa literatura o wkładzie jezuitów polskich do nauki i kultury", in *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, ed. Irena Stasiewicz-Jasiukowa (Kraków: Wydawnictwo NAM, 2004), pp. 31–68.

8. Jerzy Kochanowicz, "Źródła do dziejów oświaty jezuickiej okresu staropolskiego", in *Źródła w badaniach naukowych historii edukacji* (Toruń: Wydawnictwo Naukowe UMK, 2003), pp. 15–42.

9. Irena Stasiewicz-Jasiukowa, ed., *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami* (Kraków: Wydawnictwo WAM, 2004).

events and developments of Polish-Lithuanian Jesuit history are deeply interconnected with the culture and history of the Commonwealth itself, I turn to its description first.

4.1.1. Introduction to the Polish-Lithuanian Commonwealth

While the fourteenth century was a period of crisis for Western Europe, afflicted by wars, economic regress, and not least the Black Death, Eastern Europe experienced it as a time of political and economical growth. At the end of the century, the Kingdom of Poland and the Grand Duchy of Lithuania emerged as new powers, albeit surrounded and threatened in their existence by the Teutonic Order in the north, Muscovy in the east, and the Tatars in the southeast of their lands. In order to better their chances at survival, both parties strove for a union as early as 1385, but differences in political aspirations as well as traditions and society again and again thwarted respective attempts for almost two hundred years. It was only in July 1569 that the Polish-Lithuanian Commonwealth was finally established, with a joint election of a common ruler, a joint parliament called Sejm,[10] and a common foreign policy; the interior administration and legal codes were kept separate, however.[11]

This formal separation was contingent on the differences in culture, interests, and resources between the two states, now needing to function as one entity. To paint a picture of the situation, the newly minted union

> "encompassed most of the territory between the Baltic and the Black Seas and from Silesia to the very gates of Moscow. At the time the Polish Commonwealth was the largest state in Europe, if one excludes the vast underpopulated expanses of Muscovy. It covered an area of some 815,000 square kilometers (315,000 square miles), stretching over mountain, plain, forest, and bog and including some of the poorest sandy soil as well as the most fertile black earth in Europe. The population of the Commonwealth was nearly ten million, equal to that of Italy and of the Iberian Peninsula, twice that of England, and two-thirds that of France. Only about forty percent were Poles, and they were concentrated in about twenty percent of the area. The settled peasantry was made up of three principal ethnic groups, Polish, Lithuanian, and Ruthene, and its lifestyle varied considerably across the country. The free land-owning peasentry of Greater Poland (Wielkopolska)

10. The pronunciation is [sɛjm].
11. Henryk Samsonowicz, "Polish politics and society under the Jagiellonian monarchy", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), pp. 52–56.

> had little in common with the primitive serfs of Lithuania or Byelorussia in either standard of living or outlook."[12]

Although the Commonwealth was headed by a king, the true power lay with the noble class, the so called szlachta.[13] While often equated with and translated to nobility or gentry, szlachta can rather be compared to Scottish clans; membership was independent of monetary wealth, the possession of lands, or even bestowal by any kind of ruler. Before the end of the sixteenth century, the Polish-Lithuanian szlachta, comprising one of the highest proportions of noblemen among the population in all of Europe,[14] had secured a number of far reaching privileges in exchange for the obligation to provide unpaid military service: no taxation on hereditary noble land without consent, no imprisonment of noblemen without formal conviction, monopoly on acquiring and owning land estates, full jurisdiction over their serfs, no mobilization without consent of the local parliaments, no new legislation without consent of the (exclusively noble) Sejm, and separate tribunals for cases involving noblemen without any royal participation.[15] These extensive prerogatives further included the right to a free election of the king—there was no hereditary monarchy in the Commonwealth—as well as the right to rebellion, and were securitized in documents.[16]

But not all members of the szlachta could make equal use of this collection of privileges, albeit being entitled to it. The "aristocracy by itself constituted a social microcosm, with

12. Adam Zamoyski, "History of Poland in the 16th–18th Centuries", in *Land of the Winged Horsemen : Art in Poland 1572–1764*, ed. Jan K. Ostrowski et al. (Alexandria, Virginia: Art Services International in association with Yale University Press, 1999), p. 27. See the same page for a description of life in Polish cities of the time. With particular regard to the population numbers, Irena Gieysztorowa, "Research into the Demographic History of Poland : A Provisional Summing-Up", *Acta Poloniae Historica* 18 (1968): pp. 5–17, provides a more in-depth survey.

13. The pronunciation is [ʂlaxta]. For a comprehensive study of the nature, development, and impact of the szlachta between 1569 and 1795, see Robert I. Frost, "The Nobility of Poland-Lithuania, 1569–1795", in *The European nobilities in the seventeenth and eighteenth centuries*, ed. Hamish M. Scott, vol. 2 (London: Longman, 1995), pp. 183–222; also chapter 7 in Norman Davies, *God's Playground: A History of Poland*, vol. I (Oxford: Clarendon Press, 1981), pp. 201–255.

14. The 'exact' percentage is not entirely clear. A long-standing assumption puts the number at 8–10 percent, for example repeated in Daniel Stone, *The Polish-Lithuanian State, 1386–1795* (Seattle: University of Washington Press, 2001), p. 77, or in the classic monograph by Davies, *God's Playground: A History of Poland*, p. 202. On the other hand, Frost, "The Nobility of Poland-Lithuania, 1569–1795", pp. 191–193, discusses percentage figures and distributions and gives the lower number of 6–7.5 percent. Finally, Urszula Augustyniak, *History of the Polish-Lithuanian Commonwealth : State – Society – Culture*, ed. Iwo Hryniewicz (Frankfurt am Main: Peter Lang, 2015), also deems the 10 percent to be too high (p. 246) after giving similar numbers (p. 244).

15. Frost, "The Nobility of Poland-Lithuania, 1569–1795", pp. 183–284. Not all of these privileges were enforced in practice. The monopoly on acquiring land, for example, could easily be evaded by burghers, provided they had enough local influence and money (p. 195).

16. Stone, *The Polish-Lithuanian State, 1386–1795*, pp. 119–120.

its own ruling elite, plebeian class and a self-centered third estate",[17] separated by fortune and most of all property. As particularly only those with landownership were allowed active participation in the local parliaments, a basic distinction can be made between landowning and landless szlachta.[18] At the very top of the first group stood wealthy and propertied magnates who often entertained large followings and private armies. Beneath them, but still in the same group, the lower landowning szlachta had fewer subordinates and serfs and maintained smaller and poorer courts, if any.

The second group was likewise two-tiered. First, there was the szlachta who possessed no land of its own but was able to rent it, and then there were those who were not only entirely landless, but who in addition lived in service to other noblemen or who were forced to work in professions outside of running farmsteads. Without any say in the parliaments, the landless used to gather at the courts of richer family and friends in hopes of finding both legal and financial support.[19]

Despite this pronounced heterogeneity in terms of property, the szlachta found a vital connecting element in their common ideology. Following the Renaissance ideal of a return to and a reconnection with ancient thought and ancestry, Polish humanists of the fifteenth and sixteenth centuries theorized that the Polish-Lithuanian people descended from an ancient Iranian warrior and horse people called the Sarmatians. Towards the end of the sixteenth century, the szlachta monopolized this mythical story of origin for itself; towards the end of the eighteenth century, the Polish term 'sarmatyzm' (Sarmatism or Sarmatianism) first appeared as a negatively connoted description.[20] Sarmatism fostered a feeling of unity and identification not only among the noblemen, but also among the general population, "creating a powerful sense of distinctiveness and

17. Barbara Grochulska, "The place of the Enlightenment in Polish social history", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), p. 248.

18. The following descriptions are from Emanuel Rostorowski, "Ilu było w Rzeczypospolitej obywateli szlachty?", *Kwartalnik historyczny*, nos. 94/3 (1987): p. 31–33.

19. The differences in financial status among the szlachta as well as the political consequences resulting from these differences and their influence on noble, clerical, and royal authority in the Commonwealth are discussed in Zamoyski, "History of Poland in the 16th–18th Centuries", pp. 36–37; Andrzej Wyczański, "The problem of authority in sixteenth-century Poland: an essay in reinterpretation", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), pp. 96–108; and Antoni Mączak, "The structure of power in the Commonwealth of the sixteenth and seventeenth centuries", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), pp. 113–134.

20. Martin Faber, "Das Streben des polnischen Adels nach dem Erhalt seiner Privilegien : Zur ursprünglichen Bedeutung des Wortes ‚Sarmatismus'", *Jahrbücher für Geschichte Osteuropas* 57, no. 3 (2009): pp. 378–379. In contrast to the other literature referred to in this paragraph that focuses mostly on the everyday-life characteristics of Sarmatism in the Commonwealth, Faber and Hans-Jürgen Bömelburg, "Sarmatismus – Zur Begriffsgeschichte und den Chancen und Grenzen als forschungsleitender Begriff", *Jahrbücher für Geschichte Osteuropas* 57, no. 3 (2009): pp. 402–408, cover its conceptual history and its significance for the szlachta.

superiority to other nations that bears comparison with modern Russian and American messianic tendencies".[21] It came with a love of ceremony and rituals, emphasized food and banqueting, and embraced oriental influences with regards to fashion and art.[22]

The unifying role that the common belief in their Sarmatian ancestors played for the szlachta and the lower classes of the Commonwealth was usually assumed by religion in other states. But the earlier described multiethnicity of the Polish-Lithuanian population also came with a religious pluralism, encompassing Roman Catholics, Russian Orthodox Christians, Protestants of various denominations, Jews, Muslims, and members of the Armenian Apostolic Church, just to name a few.[23] While the Roman Catholics posed the largest among these communities, they still made up less than half of the population, and, even combined with the Protestants, barely reached over 50 percent.[24]

Hoping to spare the Commonwealth the religious wars that were raging in Western Europe in the wake of the Reformation, a 1573 law had granted religious freedom to nobles and other free persons, although it did not provide any executive measures to ensure compliance.[25] Initially, both Catholic and Orthodox szlachta acted supportively towards Protestant noblemen, mostly out of fear that cutting back their privileges might eventually lead to the loss of privileges regardless of faith.[26] Over the course of the

21. Stone, *The Polish-Lithuanian State, 1386–1795*, p. 212.

22. Stone, *The Polish-Lithuanian State, 1386–1795*, p. 213; Thomas DaCosta Kaufmann, "Definition and Self-Definition in Polish Culture and Art", in *Land of the Winged Horsemen : Art in Poland 1572–1764*, ed. Jan K. Ostrowski et al. (Alexandria, Virginia: Art Services International in association with Yale University Press, 1999), p. 17. Especially with regards to fashion and art, many contemporary paintings are shown in Zdzisław Żygulski, "The Impact of the Orient on the Culture of Old Poland", in *Land of the Winged Horsemen : Art in Poland 1572–1764*, ed. Jan K. Ostrowski et al. (Alexandria, Virginia: Art Services International in association with Yale University Press, 1999), pp. 69–79.

23. See Jerzy Kloczowski, *A History of Polish Christianity* (Cambridge: Cambridge University Press, 2000), p. 91 for the sixteenth and Davies, *God's Playground: A History of Poland*, p. 162 for the seventeenth century.

24. See the two diagrams on religious communities in the Commonwealth in 1660 and 1772 in Davies, *God's Playground: A History of Poland*, p. 162. The massive west shift of Poland following World War II alone renders any comparison with modern surveys on religious affiliation futile, but the numbers gathered during an official census of the Polish nation in 2011 are still worth a look. According to the census, 87.58 percent of the population identify as Roman Catholics, followed by Orthodox Christians (0.41 percent) and Jehova's Witnesses (0.36 percent) before Lutherans (0.18 percent) in the forth place. Lucyna Nowak et al., *Ludność. Stan i struktura demograficzno-społeczna : Narodowy Spis Powszechny Ludności i Mieszkań 2011*, ed. Mariusz Chmielewski (Warzawa: Zakład Wydawnictw Statystycznych, 2013), p. 99.

25. At the same time, feudal lords were given the right to force their subjects to accept their beliefs, something that they apparently rarely chose to do. See Stone, *The Polish-Lithuanian State, 1386–1795*, p. 120. The religious diversity of the Polish-Lithuanian Commonwealth is an often discussed topic. Aside from the works I reference directly in this context, I would additionally recommend Christopher Garbowski, *Religious Life in Poland : History, Diversity and Modern Issues* (Jefferson, North Carolina: McFarland, 2014), pp. 12–17, and Felix Paul Biermann, "Überzeugung und Zwang bei der Christianisierung Polens unter den ersten Piasten", in *Schwertmission : Gewalt und Christianisierung im Mittelalter*, ed. Hermann Kamp and Martin Kroker (Paderborn: Ferdinand Schöningh, 2013), for a compact insight into how this diversity came to be.

26. When the szlachta rebelled against King Sigismund III Vasa (1566–1632, reign in Poland-Lithuania

seventeenth and eighteenth centuries, however, Catholicism (re)gained strength in the Commonwealth for a variety of reasons. The different Protestant denominations were unable to present a united front against the Counterreformation, and neither was one of them dominant enough to take the lead by itself. In addition, there was a stark decline of Protestant communities in the first place, since many of the magnates who had offered support and protection had either died or converted back to Catholicism.[27]

The political state of the Commonwealth played another important role.[28] Towards the beginning of the seventeenth century, it was one of the most powerful states in eastern Europe, with its neighbors being preoccupied with their own internal and external crises. However, Poland-Lithuania failed to take advantage of this situation, and subsequently found itself outside of the European system of alliances and surrounded by strengthened non-Catholic powers—Orthodox Russia in the east, Protestant German principalities in the west, Lutheran Sweden in the north, Ottoman Turks in the south. This, in turn, gave the Polish Catholic church good reason to promote a united belief against the threat of the heretic neighbors. The fear also turned inwards, manifesting itself in propaganda about Protestant nationals collaborating with the enemies. This created so much pressure that some Protestant szlachta actually did what they were accused of, or at least hoped for a foreign intervention that might improve their conditions.[29]

The circumstances of the Commonwealth worsened considerably in the aftermath of the Cossack Uprising of 1648. The Cossacks, a group of free, independent horse people roaming the Eastern margins, revolted against their treatment in the Commonwealth. While they were often called to military service in the Polish-Lithuanian army because of their skills and numbers, they received no privileges in return; the Cossacks saw themselves as noblemen and demanded to be raised into noble ranks, whereas the szlachta regarded them as serfs and "the Sejm constitutions referred to them as the 'traitors and enemies'."[30] The uprising quickly turned into war, beginning a "disastrous series of long-term conflicts between the Commonwealth and its non-Catholic enemies. In 1654 Orthodox Russia came to the aid of the Cossacks, while in the following year Lutheran

1587–1632) in 1606–1608, he was hence not only accused of religious intolerance, but also of striving towards absolute power. Janusz Tazbir, "The fate of Polish Protestantism in the seventeenth century", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), p. 203.

27. Augustyniak, *History of the Polish-Lithuanian Commonwealth : State – Society – Culture*, pp. 191–192; Tazbir, "The fate of Polish Protestantism in the seventeenth century", pp. 202–204.

28. A concise account can be found in Józef Andrzej Gierowski, "The international position of Poland in the seventeenth and eighteenth centuries", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), , here especially pp. 223–227.

29. Tazbir, "The fate of Polish Protestantism in the seventeenth century", p. 205, pp. 207–207.

30. Augustyniak, *History of the Polish-Lithuanian Commonwealth : State – Society – Culture*, p. 253.

Sweden fell upon Poland, soon to be assisted by ducal Prussia and Transylvania. The treaty of Oliwa in 1660 brought only a temporary halt to military operations, which soon flared anew in wars against Russia and the Ottoman empire".[31] Peace was finally signed in 1668, but the crises of the past twenty years were more than enough to decimate the population,[32] destroy settlements and movable wealth, and severely damage the economy to a point from which the Commonwealth could not recover.[33] The consequences for the structure of the state were devastating:

> "In effect, the perceived community of interest of the szlachta had become largely fictitious. The gap between the richest and the poorest had grown immense, destroying the cooperative ethic that had founded the Commonwealth. The decline in standards of education and the loss of the humanist vision of the sixteenth century aggravated this. The szlachta was more and more concentrated on local interests and not on those of the country as a whole, and from 1652 onward single deputies to the Sejm began to use the veto to strike down legislation that did not suit their constituency or their local magnate. Crowds of poor szlachta, who lived on the generosity of magnates but enjoyed full political rights, were easy to manipulate. The political education of the Populus Polonus was simply not up to the governance of the country."[34]

Despite short periods of military, social, and cultural respite such as under King Jan III Sobieski (1629–1696, reign 1674–1696), who led the allied forces of Poland-Lithuania and Austria-Hungary to victory against the invading Ottoman Turks at Vienna in 1683, the decline of the Commonwealth continued.[35] Especially the Great Northern War (1700–1721), fought in changing coalitions led by Sweden and Russia over the supremacy in the Baltic area, proved devastating for Poland-Lithuania, largely acting as the battleground. The war once more decimated the population, destroyed settlements, brought illness and famine, and left the Commonwealth in a weakened state that the Russian Emperor Peter

31. Tazbir, "The fate of Polish Protestantism in the seventeenth century", p. 207.

32. Poland's population is estimated to have declined by a third between the seventeenth and eighteenth centuries. Thomas DaCosta Kaufmann, *Court, Cloister, and City : The Art and Culture of Central Europe 1450–1800*, ed. Jan K. Ostrowski et al. (Chicago: The University of Chicago Press, 1995), p. 283.

33. Zamoyski, "History of Poland in the 16th–18th Centuries", p. 34.

34. Ibid.

35. For a characterization of Sobieski, see Stone, *The Polish-Lithuanian State, 1386–1795*, pp. 236–241, and Davies, *God's Playground: A History of Poland*, pp. 473–491. Augustyniak, *History of the Polish-Lithuanian Commonwealth : State – Society – Culture*, mentions Sobieski as patron of astronomer Johannes Hevelius (1611–1687) and host of ballets and theater plays at his court, pp. 437–478 and p. 441 respectively.

the Great (1672–1725, reign 1682–1725) utilized to legally install Russia as the "'protector' of Polish freedom and integrity"[36] in 1717, essentially terminating the sovereignty of the Commonwealth and inadvertently taking the first step towards the eventual Partitions of Poland between 1772 and 1795.

4.1.2. Jesuit beginnings and anti-Jesuit sentiments in Poland-Lithuania

In terms of duration, Jesuit history in the Polish-Lithuanian Commonwealth pretty much coincides with the history of the Commonwealth itself. Where the latter officially came together in 1569, the first Jesuit college in Poland-Lithuania was founded in 1565. Prince-Bishop Stanisław Hozjusz (1504–1579) of the Bishopric of Warmia called upon the Jesuits to settle in the town of Braniewo, providing the necessary funds for the *Collegium Hosianum*[37] in order to both facilitate a better education in his diocese and take action against Protestants in the region.[38]

The *Collegium Hosianum* became a model for subsequent college foundations in the Commonwealth. It accommodated students from the entire Baltic regions and offered diverse courses such as in Polish, German, mathematics, and astronomy.[39] Due to its quick growth, it soon had to deal with insufficient funding and lacking facilities; in the 1580s, 80 Jesuits had to be supported by what would have been suitable for 20 people.[40]

The Jesuit expansion in the Commonwealth continued. In 1574, a separate Polish province was established—prior, the Polish-Lithuanian Jesuits were subordinate to the Austrian province—and in 1608, it was in turn divided into a Polish and a Lithuanian province with a total of 15 colleges and 611 Jesuits.[41]

During this time, the Society found a sponsor and patron in the Polish King Stefan Batory (1533–1586, reign 1575–1586) "who, as a fervent Catholic monarch, was very much interested in idealogical support of the Society of Jesus".[42] By establishing themselves in recently conquered territories in the east and north, they could help incorporate them into the Commonwealth via education and missionary activities; Batory hence facilitated

36. Zamoyski, "History of Poland in the 16th–18th Centuries", p. 35.
37. The compound still exists today and houses a vocational school.
38. Grzebień and Piechnik, "Polonia", col. 3173. Sławomir Kościelak, "Jezuici w trzech wielkich miastach pruskich w XVI-XVIII w.", *Hereditas Monasteriorum* 3 (2013): pp. 155–187, in particular details how the Jesuits fared in the Protestant Hanseatic cities of Gdańsk, Elbląg, and Toruń, the first two of which are close to Braniewo.
39. Ludwik Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", *Studia Bobolanum* 3 (2010): p. 45.
40. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 63.
41. Ibid., pp. 540–541.
42. Stanisław Obirek, "Jesuits in Poland and eastern Europe", in *The Cambridge Companion to the Jesuits*, ed. Thomas Worcester (Cambridge: Cambridge University Press, 2008), p. 142.

the foundation of colleges in Polotsk, Riga, and Tartu.[43]

He had also chosen the Polish Jesuit preacher, rhetorician, and hagiographer Piotr Skarga (1536–1612) as a personal advisor and assistant.[44] and often called upon Jesuit priests to act as chaplains at courts or in the army[45] On the king's behalf, Skarga organized, among others, the Vilnius college in 1569,[46] where he worked as a teacher, substitute rector, and finally rector proper between 1573 and 1584.[47] Granted the status of a university in 1578/1579, Vilnius quickly became an intellectual center especially for philosophy and theology, and a successful site of Jesuit activities against the Reformation.[48] A course of mathematics was established as early as 1572; towards the eighteenth century, the focus changed from theoretical subjects such as logic and metaphysics to practical ones such as experimental physics and astronomy.[49] The contemporary appeal of the Jesuit university in Vilnius becomes evident by the increase in students between 1572 and 1596: the numbers jumped from 200 to more than 800.[50]

In order to show gratitude for Batory's assistance but also gently prompt him for its continuation, the Jesuit leadership decided to have Christoph Clavius dedicate his *Gnomonices libri octo* (Eight books on sundials) to the king. As Batory is not known to have had any particular relationship with mathematics, the work published in 1581 is hence a prime example of a book whose frontispiece was intended for a very different audience than its actual contents.

43. Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", p. 38.

44. K. Drzymała and L. Grzebień, "Skarga, Piotr", in *Diccionario histórico de la Compañía de Jesús*, ed. Charles O'Neill, vol. IV (Madrid: Universidad Pontifica Comillas, 2001), col. 3588. On Skarga's rhetoric skills, contemporary success as an author, and his and other Jesuits' merits in propagating and developing the Polish language, see Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", pp. 47–48; Irena Bajerowa, "Jezuici w dziejach języka polskiego", in *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, ed. Irena Stasiewicz-Jasiukowa (Kraków: Wydawnictwo NAM, 2004), pp. 427–429; and Czesław Miłosz, *The History of Polish Literature* (Berkeley: University of California Press, 1983), p. 95. On the influence of Jesuits on the development of Lithuanian, Latvian, Estonian, and Russian, see Justyna Łukaszewska-Haberkowa, *Wpływ pierwszego pokolenia polskich Jezuitów na życie kulturalne i religijne Rzeczypospolitej Obojga Narodów w latach 1564–1608* (Kraków: Wydawnictwo WAM, 2014), pp. 66–71; and Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", pp. 48–51. Finally, Grzebień, "Dotychczasowa literatura o wkładzie jezuitów polskich do nauki i kultury", provides a bibliography concerning the Jesuit contribution the languages in the Commonwealth on pp. 51–56.
Skarga is an influential, yet not easily to grasp figure in Polish history. Despite the age of the work, the short biography in Miłosz, *The History of Polish Literature*, pp. 90–95, is very much worth reading. It locates Skarga in his time and sheds light on his later reception in Poland, as well.

45. Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", p. 38.

46. Stone, *The Polish-Lithuanian State, 1386–1795*, p. 126.

47. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 619.

48. Grzebień and Piechnik, "Polonia", col. 3173.

49. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 741.

50. Grzebień and Piechnik, "Polonia", col. 3173.

The aim of the richly decorated architectural frame, shown in Figure 4.1 on page 152, was to impress the Polish king and his confidants and convince them that the Society was more than worthy of further support. Within this frame, the topic of the *Gnomonices* is only marginally referenced: two armillary spheres top off the tympanum on the left and right, and at the bottom, a diagram of a sundial is drawn. In the dedicatory letter to his work, Clavius praises Batory's efforts for the defense and propagation of the Catholic faith; establishing a connection to the contents, he states that human efforts that lack divine guidance and enlightenment are as useless as a sundial in the dark.

After Batory's death in 1586, Skarga remained a central figure at the Polish court; the succeeding king Zygmunt III Wasa (1566–1632, reign 1587–1632) appointed him as his private confessor in 1588.[51] The new monarch had been brought up and educated by Jesuits and considered his teachers along with the Society itself as his mentors and spiritual guides.[52] Although Zygmunt—like all Polish-Lithuanian kings—had sworn to uphold religious tolerance, he pursued anti-Protestant politics by way of condoning mob attacks against Protestants and disregarding Protestant szlachta when assigning offices.[53] He furthermore attempted to reform and limit the szlachta's privileges and strengthen the central government, something that would have greatly benefited politically unstable Poland-Lithuania, but was always rejected by the Sejm.[54]

Skarga, who considered the "noble democracy to be a sin"[55] and was very much in favor of establishing a hereditary monarchy, wrote and published a series of sermons in 1597 where he "introduced a religions dimension to politics, portraying national dangers as God's punishment for Poland's sins".[56] He blamed the current difficulties on religious heresy, a weakened royal power, and unpunished public transgressions such as blasphemy and luxury.[57] The growing discontent of parts of the szlachta with the king led to an eventually unsuccessful noble revolt in 1607–1609 that, among others, demanded for the Jesuits to be expelled from the Commonwealth and most of the Jesuit institutions to be closed.[58] The revolt was taking place during a time when anti-Jesuit sentiments were generally running high in the Commonwealth, evidenced by the amount and impact of anti-Jesuit pamphlets published at the end of the sixteenth and

51. Drzymała and Grzebień, "Skarga, Piotr", col. 3588.
52. Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", p. 38.
53. Stone, *The Polish-Lithuanian State, 1386–1795*, pp. 134.
54. Ibid., p. 132–137.
55. Davies, *God's Playground: A History of Poland*, p. 359.
56. Stone, *The Polish-Lithuanian State, 1386–1795*, p. 215.
57. Miłosz, *The History of Polish Literature*, p. 92.
58. P. 52 Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w."; Pavone, *The Wily Jesuits and the Monita secreta : The Forget Secret Instructions of the Jesuits: Myth and Reality*, p. 195; Grzebień and Piechnik, "Polonia", col. 3176.

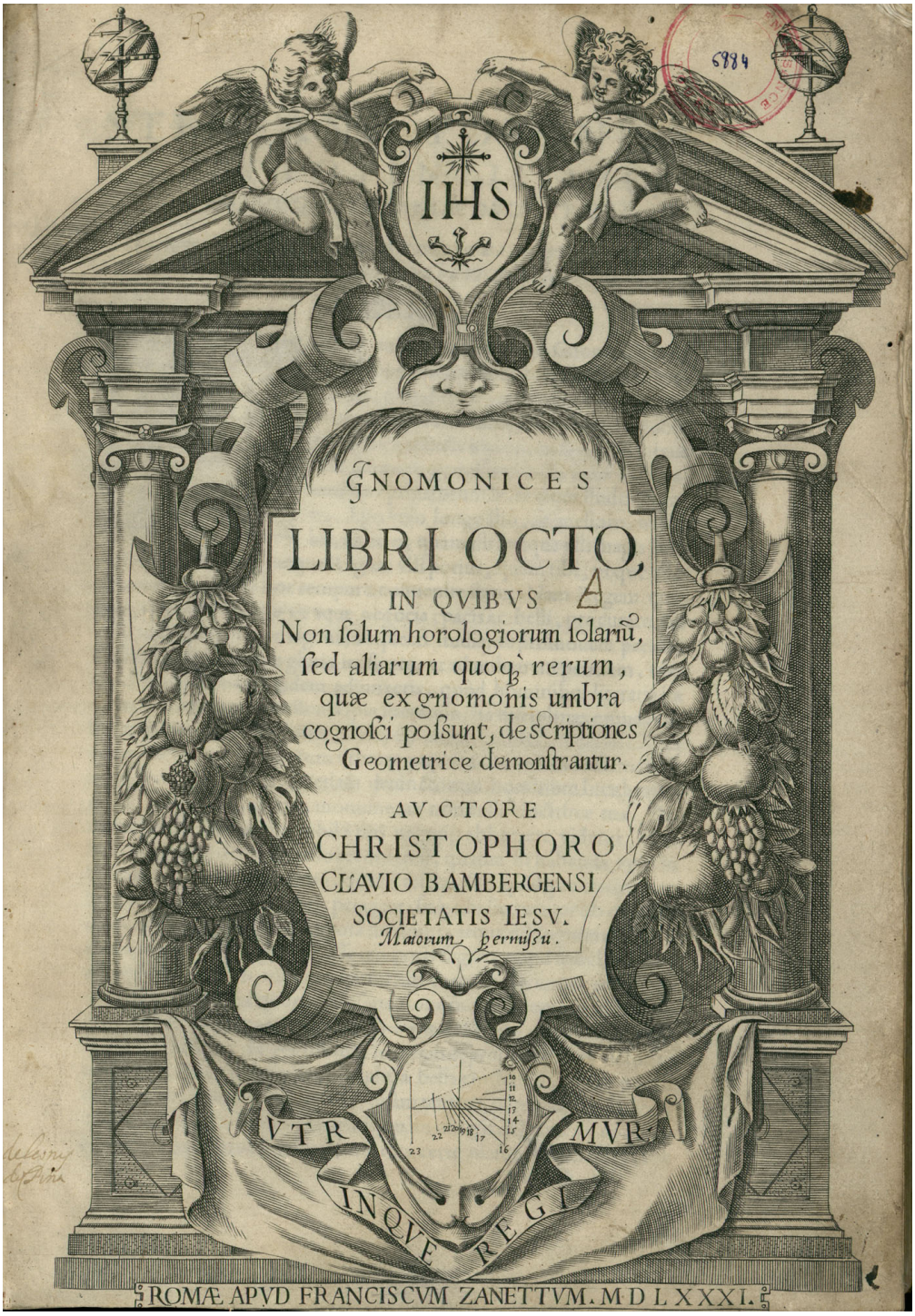


Figure 4.1.: Frontispiece to Christoph Clavius' *Gnomonices libri octo* (1581). Source: Centre d'Études Supérieures de la Renaissance (Tours) via Bibliothèques Virtuelles Humanistes (CC BY-NC-ND 2.0 FR).

the beginning of the seventeenth centuries.

One of the earliest diatribes that truly left an impression is an anonymous publication from early May 1586, the *Newe Zeyttung, Waarhaffte Histori von der Mörderischen unnd erbärmblichen that, so durch die Jesuwiter zü Crackauw in Polen geschehen, und wie sy darumb jhren verdienten lon empfangen*[59] (New paper, true history of the homicidal and pathetic act as committed by the Jesuits of Kraków in Poland, and how they received their deserved punishment). It originated in Gdańsk, a Protestant German-speaking town whose burghers refused to convert back to Catholicism.[60] The alleged newspaper relays the story of four Jesuit missionaries who were sent to Gdańsk by the bishop of Mainz on request by King Stefan Batory. It purports that it was common practice among Jesuits to keep female lovers, not necessarily on a voluntary basis, disguise them as Jesuits, and not even shy away from murder in order to keep the relationships secret and get rid of any conceived children.

The *Newe Zeyttung* was circulated broadly not only in the Commonwealth, but also in Germany and Austria.[61] Mere weeks after it was published, it gave rise to correspondence between the bishop of Mainz and the Polish king, involved as peripheral figures.[62] Among others, Batory wrote that the report was so fantastical in its tale that it disproved itself, but had testimonials in favor of the Society sent to the bishop, regardless. A collection of the pamphlet, the resulted correspondence, the testimonials, and their German translations was then published in Mainz in August 1586.[63]

The next noteworthy anti-Jesuit publication appeared anonymously in Kraków in 1590 under the title *Equitis Poloni in Iesuitas actio prima*[64] (First action of the Polish knight against the Jesuits), and was translated into German in 1592.[65] The only 19 pages long tract—20 including the title page—"accuses the Jesuits of being ambitious plebeians, anxiously seeking to seize the property of others, and claims that, with the majority of their teachers being foreigners, they despised the golden freedom of the Polish nobility and wanted to introduce absolutism into Poland".[66] These accusations and defamations

59. *Newe Zeyttung, Waarhaffte Histori von der Mörderischen unnd erbärmblichen that, so durch die Jesuwiter zü Crackauw in Polen geschehen, und wie sy darumb ihren verdienten lon empfangen* (Gdańsk: Jacob Roth, 1586).

60. Zbigniew Nowak, "Gdański paszkwil antyjezuicki z 1586 roku (Początki literatury antyjezuickiej w Polsce)", *Rocznik Gdański* XXV (1966): pp. 51–71.

61. Ibid., p. 60.

62. Ibid., p. 60–61.

63. Ibid., p. 62.

64. *Equitis Poloni In Iesuitas Actio Prima* (1591).

65. Nowak, "Gdański paszkwil antyjezuicki z 1586 roku (Początki literatury antyjezuickiej w Polsce)", p. 54.

66. "[A]cusa a los jesuitas de ser plebeyos ambiciosos, que buscaban con ansia adueñarse de la propiedad ajena, y afirma que, siendo la mayoría de sus profesores extranjeros, despreciaban la libertad áurea de la nobleza polaca y querían introducir el absolutismo en Polonia" Grzebień and Piechnik, "Polonia", col. 3176.

are just one example in a whole series of anti-Jesuit writings originating from around the Academy of Kraków,[67] with the *Equitis Poloni* supposedly having been written by the rector of the Academy himself.[68]

The antagonism displayed by the Academy and its environment was mostly caused by the fact that, in regards to providing education in the Commonwealth, it now had a serious and quickly expanding competitor in the Jesuits. At the same time, the Society itself had to compete against a number of other male orders—among them the Benedictines, Cistercians, Carthusians, Capuchins, and Dominicans—which had been working on Polish-Lithuanian grounds since long before.[69] The Academy repeatedly

67. On the character and publication practices of polemical writings, especially concerning the Kraków Academy, see Magdalena Komorowska, "In the Eye of the Storm: Books in the Conflict between the Jesuits and the University of Kraków (1622–1634)", in *Publishing Subversive Texts in Elizabethan England and the Polish-Lithuanian Commonwealth*, ed. Teresa Bela, Clarinda Calma, and Jolanta Rzegocka (Leiden: Brill, 2016), pp. 56–71. A short overview over anti-Jesuit literature in Poland can be found in Janusz Tazbir, "Literatura antyjezuicka w Polsce", in *Jezuici a kultura polska. Materiały sympozjum z okazji Jubileuszu 500-lecia urodzin Ignacego Loyoli (1491–1991) i 450-lecia powstania Towarzystwa Jezusowego (1540–1990), Kraków, 15–17 lutego 1991 r.* Ed. Ludwik Grzebień and Stanisław Obirek (Kraków: Wydawnictwo WAM, 1993), pp. 311–333. 30 years earlier, the same author also published an anthology of various anti-Jesuit pamphlets from Poland-Lithuania: Janusz Tazbir, *Literatura antyjezuicka w Polsce 1578–1625 : Antologia* (Warszawa: Ludowa Spółdzielnia Wydawnicza, 1963). Finally, Wacław Urban, "Akademia Krakowska w dobie reformacji i wczesnej kontrreformacji (1549–1632)", in *Dzieje Uniwersytetu Jagiellońskiego w latach 1364–1764*, ed. Kazimierz Lepszy (Kraków: Państwowe Wydawnictwo Naukowe, 1946), p. 280, speaks of the great variety of these diatribes in terms of authors—ranging from students to members of the Sejm—and intended audiences—ranging from simple songs written for the illiterate to essays for the highest szlachta.

68. Justyna Dąbkowska-Kujko, "Jezuicka paideia", in *Humanitas i christianitas w kulturze polskiej*, ed. M. Hanusiewicz-Lavallee (Warszawa: Wydawnictwo Neriton, 2009), p. 153.

69. The older article by Adam Chruszczewski, "Les Ordres Religieux en Pologne au XVIIe et au XVIIIe s.", in *Le millénaire du catholicisme en Pologne = Poland's millennium of Catholicism*, ed. Marian Rechowicz (Lublin: Towarzystwo Naukowe Katolickiego Uniwersytetu Lubelskiego, 1969), pp. 119–125, gives a brief, general account of male religious orders in the Commonwealth, while Gaetano Platania, "Two Religious Orders in Sixteenth- and Seventeenth-Century Poland: The Jesuits and the Arrival of the Capuchin Friars", in *Papacy, religious orders, and international politics in the sixteenth and seventeenth centuries*, ed. Massimo Carlo Giannini (Roma: Viella, 2013), pp. 182–209, and P. T. Stolarski, "Dominican-Jesuit Rivalry and the Politics of Catholic Renewal in Poland 1564–1648", *Journal of Ecclesiastical History* 62, no. 2 (2011): pp. 255–272, deal specifically with the relationships between the Society of Jesus and the Dominicans and Capuchins. Opposing accounts exist on the topic of which order was the dominating one. Davies, *God's Playground: A History of Poland*, writes on p. 168 that "from their introduction in 1564 to their suspension in 1773, the Jesuits never controlled more than 70 out of the Republic's 1200 monastic and religious houses. Even in the educational sphere, they never enjoyed anything which resembled a monopoly." This is further supported by the numbers found in Platania, "Two Religious Orders in Sixteenth- and Seventeenth-Century Poland: The Jesuits and the Arrival of the Capuchin Friars", p. 197, and Chruszczewski, "Les Ordres Religieux en Pologne au XVIIe et au XVIIIe s.", p. 123. In contrast, Richard Butterwick-Pawlikowski, "Before and After Suppression : Jesuits and Former Jesuits in the Polish-Lithuanian Commonwealth, c. 1750–1795", in *Jesuit Survival and Restoration : A Global History, 1773–1900*, ed. Robert A. Maryks and Jonathan Wright (Leiden: Brill, 2015), pp. 49–66, states in the first paragraph that the "Jesuits ran more schools and colleges than the other orders combined, and Jesuits were more numerous than members of any other single order", relying on a contemporary count determined by a papal nuncio to the Commonwealth (pp. 51–52). Stone, *The Polish-Lithuanian State, 1386–1795*, also reports that "Jesuits ran more than two-thirds of Poland-Lithuania's schools" (p. 313).

thwarted Jesuit attempts to attain university status for their colleges, such as in Poznań (1611–1613), Lwów (1661), Braniewo (1701), and of course Kraków itself (1634 marked the final decision against the Jesuit university, but the conflict had begun already in 1570).[70] It hence severely obstructed the development of the Society especially in the western part of the Commonwealth by preventing it from establishing intellectual centers similarly to Vilnius. This, in turn, contributed greatly to the crisis that Jesuit schooling in Poland-Lithuania entered in the seventeenth century, the focus of the subsequent section.

But Kraków was also home to people who opposed the Jesuits for political reasons, such as Jerzy Zbaraski (1574–1631), a Prince and Catholic cleric who had already clearly spoken out against the Society in the noble revolt of 1607–1609.[71] Zbaraski is attributed with having written, among others, the *Consilium de recuperanda et in posterum stabilienda pace Regni Poloniae. In quo demonstratur pacem nec constitui nec stabiliri posse, quamdiu Jesuitae in Polonia maneant. Ad illustres Regni Poloniae proceres.*[72] (Council on how to restore and hereafter maintain peace in the Kingdom of Poland. In which it is shown that peace cannot be established and maintained so long as the Jesuits remain in Poland. To the most noble Kings of Poland.), published anonymously in 1606.[73] The views expressed in the *Consilium* touch upon some points of criticism commonly brought forward against the Society of Jesus not only in Poland-Lithuania:

> "Zbaraski considered the activity of the Jesuits as especially disastrous for the internal peace in the Commonwealth, since they—as a foreign element with regard to both ethnicity and culture—fulfill the function of Spanish Habsburg spies; this was supposedly evidenced by the fact that seven of the Father Generals of the Society of Jesus were Spaniards. His aversion towards this congregation was not caused by personal resentment, but by repugnance

70. Bieś, "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności", p. 64; some details on the cases of Poznań and Kraków can, for example, be found in Grzebień and Piechnik, "Polonia", col. 3176. Older Polish literature also offers very interesting, since emotionally tinged accounts on the matter. For instance, Urban, "Akademia Krakowska w dobie reformacji i wczesnej kontrreformacji (1549–1632)", pp. 274–284, takes up the point of view of the Academy, while Stanisław Bednarski, *Upadek i odrodzenie szkół jezuickich w Polsce* (Kraków: Wydawnictwo Księży Jezuitów, 1933), pp. 25-26, clearly speaks in defense of the Society. Despite Urban's palpably anti-Jesuit tone, his narrative reads more sober than Bednarski's and contains many details concerning the political situation of the Academy at the time.

71. Pavone, "Between History and Myth: The *Monita secreta Societatis Jesu*", pp. 54–55.

72. *Consilium de recuperanda et in posterum stabilienda pace Regni Poloniae. In quo demonstratur pacem nec constitui nec stabiliri posse, quamdiu Jesuitae in Polonia maneant. Ad illustres Regni Poloniae proceres.* (1606).

73. Urszula Augustyniak, "‚Wolę mieć *religionem frigidam* niż *nullam*'. Jerzy i Krzysztof Zbarascy wobec rekatolicyzacji i zmiany systemu rządów w Rzeczypospolitej za Zygmunta III Wazy", *Odrodzenie i Reformacja w Polsce* LVIII (2014): p. 77–78.

> towards its 'monarchic' organization and the informal methods used to win leverage at European courts, especially the court of Zygmunt III."[74]

While the proximity to royal courts, the monarchical structures, and the perceived pursuit of a hidden Spanish Habsburg agenda belonged among the regular allegations,[75] Zbaraski's reproach of the Jesuits being foreign carried much more weight in the Commonwealth, based on Polish-Lithuanian peculiarities and the strong self-perception of the szlachta. Indeed, the percentage of non-Polish Jesuits in the Commonwealth was initially very high, with 74 percent in 1567, 46 percent in 1570, and 10 percent in 1599; as mentioned earlier, the administration of the Polish colleges resided with the Austrian province until 1574; and finally, until 1608, all provincials of the Polish province hailed from Italy.[76]

Aside from purportedly authoring the *Consilium*, Jerzy Zbaraski was also involved in facilitating the publication of the possibly most widespread anti-Jesuit pamphlet in the early modern period, the *Monita Secreta Societatis Iesu* (Secret admonitions of the Society of Jesus).[77] I have already discussed the author—Hieronim Zahorowski, an ex-Jesuit looking to take revenge for being expelled from the Society—and the many, translated, and continuously 'updated and expanded' editions of the *Monita Secreta* on page 32;[78] the content, mistaken for the actual Constitutions of the order that were apparently impossible to get,[79] is a collection of supposed secret instructions from Rome with the aim to help the Jesuits gain more money and influence. In a 1746 English edition of the *Monita Secreta* we hence find, for instance, Chapter 6 telling "Of proper methods for

74. "Działalność jezuitów uważał Zbaraski za szczególnie zgubną dla pokoju wewnętrznego w Rzeczypospolitej, bo – jako element obcy etnicznie i kulturowo – pełnią funkcję szpiegów Habsburgów hiszpańskich, czego dowodem miał być fakt, że siedmiu spośród zwierzchników generalnych Towarzystwa Jezusowego było Hiszpanami. Jego niechętny stosunek do tego zgromadzenia nie wynikał z prywatnych resentymentów, lecz z odrazy do "'monarchicznej"' organizacji zgromadzenia i nieformalnych metod pozyskiwania przez nie wpływów na dworach władców europejskich, a przede wszystkim na dworze Zygmunta III." Augustyniak, "‚Wolę mieć *religionem frigidam* niż *nullam*'. Jerzy i Krzysztof Zbarascy wobec rekatolicyzacji i zmiany systemu rządów w Rzeczypospolitej za Zygmunta III Wazy", pp. 81–81.

75. On Jesuit activities at court, compare footnote 78 on page 32. For the other issues, see Friedrich, *Die Jesuiten*, pp. 527–528, and Pavone, "Between History and Myth: The *Monita secreta Societatis Jesu*", p. 56.

76. Bieś, "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności", p. 59; Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", p. 53. A breakdown of the overall amount of Jesuits in the Commonwealth during this time and the proportions of Polish and foreigners among them can be found in Łukaszewska-Haberkowa, *Wpływ pierwszego pokolenia polskich Jezuitów na życie kulturalne i religijne Rzeczypospolitej Obojga Narodów w latach 1564–1608*, p. 22.

77. Augustyniak, "‚Wolę mieć *religionem frigidam* niż *nullam*'. Jerzy i Krzysztof Zbarascy wobec rekatolicyzacji i zmiany systemu rządów w Rzeczypospolitej za Zygmunta III Wazy", p. 96; Tazbir, "Hieronim Zahorowski : Zapomniany autor głośnego pamfletu", p. 348.

78. Enhancing later editions kept the accusations topical. Friedrich, *Die Jesuiten*, p. 530.

79. Ibid., p. 529.

inducing rich widows to be liberal to our Society". Chapter 12 on "Who should be kept, and favoured in the Society" is also not the only one on internal discipline.[80]

The last anti-Jesuit pamphlet that I would like to introduce is called *Gratis*. It was written by the Kraków mathematician, astronomer, cleric, professor at and later rector of the Academy Jan Brożek (1585–1652), and published anonymously in Kraków in 1625. Brożek, who was an early biographer of Nicolaus Copernicus and, among other things, mathematically investigated the question why bees build hexagonal honeycombs, conceived *Gratis* as an attack on the Jesuit educational system. He argued that it did, in fact, come with great cost and was essentially devised as a service not to the students, but to the Jesuits themselves, and defended the privilege of (non-Jesuit) academies to teach at that level. At the same time, his deliberations contain many falsehoods.[81]

The Society attempted to take action against these pamphlets by writing polemic responses themselves or calling upon help from spiritual or secular authorities, as publications without the author's or printer's name were illegal in the first place.[82] In the case of *Gratis*, the Jesuits even managed to get ahold of letters between Brożek and his printer.[83] While they did not release Brożek's name, and the Academy, under whose jurisdiction he was, did nothing to punish him, the printer was pilloried and chased out of the town, and all copies of *Gratis* were burned.[84]

4.1.3. Jesuit schooling in seventeenth century Poland-Lithuania: Crisis and reformation

Beginning as early as in the 1630s, Jesuit education underwent a crisis in the Polish-Lithuanian Commonwealth. Stanisław Bednarski (1896–1942), a Polish Jesuit historian of literature, culture, and art, treated this crisis in detail in his 1933 monograph *Upadek i odrodzenie szkół jezuickich w Polsce*[85] (Downfall and restoration of Jesuit schools in Poland), still one of the foundational works on this topic. Despite Bednarski clearly writing from an emotional point of view that is additionally shaped by his own history, his account is based on the study of early modern source material and thus offers invaluable insight.

As such, he diagnoses, in fact, a general cultural crisis of the Polish Jesuits, with the

80. Hieronym Zahorowski, *Secreta monita Societatis Jesu = The secret instructions of the Jesuits.* (London: Printed for J. Walthoe; and sold by M. Cooper, 1746).

81. Grzebień and Piechnik, "Polonia", col. 3176.

82. Komorowska, "In the Eye of the Storm: Books in the Conflict between the Jesuits and the University of Kraków (1622–1634)", pp. 64, 70.

83. Ibid., p. 69.

84. Paulina Buchwald-Pelcowa, *Cenzura w dawnej Polsce* (Warszawa: Wydawnictwo SBP, 1997), pp. 145–146.

85. Bednarski, *Upadek i odrodzenie szkół jezuickich w Polsce*.

crisis in teaching being its most visible and gravest aspect.[86] His analysis of contemporary Jesuit correspondence reveals not only the existing problems, but also that the Society was well aware of them. The earliest letter studied by Bednarski was written in 1645 by an Italian Jesuit charged with inspecting the Polish province. He bemoans the declining quality of lower Jesuit schools and complains that Jesuit students are admitted to higher studies prematurely, meaning that they are not sufficiently trained in order to take up their responsibilities as teachers of lower courses.[87]

Subsequent reports from inspectors and provincials—Bednarski counts over 150 in total until 1773[88]—furthermore admonish the Polish Jesuits for a too frequent use of theater and music performances, too many free days, a lacking enthusiasm in completing their tasks, lacking language skills, laziness, and overall carelessness.[89] The documented issues remain the same over the years, as does the assigned solution of stricter controls through superiors, but little seems to have changed.

As for the causes of the crisis, Bednarski and other scholars identify a plethora of both internal and external reasons. The antagonism by the Kraków Academy prevented the Society of Jesus from establishing bigger intellectual centers in the western parts of the Commonwealth, leading to a change of focus towards the east, towards more missionary work and pastoral care. The noble revolt in the 1610s furthermore directed Jesuit attention inwards, away from any open politically charged action;[90] it also caused a general contempt against the fine arts and architectural studies, as the king was accused of "wasting time with artists, and of surrendering to 'artistic foolery' rather than attending to politics and war".[91] The resulting lack of demand for higher studies was amplified by the fact that Polish youth held being a courtier in much higher esteem, in the first place,[92] and the frequent change and overall lack of teachers in Jesuit schools along with the growing obsolescence of the *Ratio Studiorum* made an advanced Jesuit education rather undesirable, anyway.[93]

The specific political and cultural situations in the Commonwealth did their part, as

86. Bednarski, *Upadek i odrodzenie szkół jezuickich w Polsce*, p. 24.
87. Ibid., p. 33.
88. Ibid., p. 34.
89. Ibid., pp. 34–37.
90. Ibid., pp. 24–25.
91. This attitude only changed when the szlachta realized that the arts, in particular residential architecture, could be utilized for political propaganda. Andrzej Wyrobisz, "The arts and social prestige in Poland between the sixteenth and eighteenth centuries", in *A Republic of Nobles : Studies in Polish History to 1864*, ed. J. K. Fedorowicz (Cambridge: Cambridge University Press, 1982), pp. 157–160, quote on p. 158.
92. Ludwik Piechnik, "Studium matematyczne i projekt akademii wojskowej Bartłomieja Wąsowskiego", *Nasza przeszłość* 36 (1971): p. 178.
93. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 542.

well. The many wars in the seventeenth and eighteenth centuries, followed by famines, epidemics, and economical ruin, decimated the Polish-Lithuanian population, and diminished Jesuit numbers by 58 percent.[94] In times of peace, the Jesuits began to adopt the culture of the Sarmatian szlachta and pick up negative habits: a focus on the Commonwealth, rejection of foreign influences, favoring of noble origin, wrongful assumption of noble names,[95] and excessive eating and drinking.[96] These Sarmatian tendencies and the difficult war-torn state of the Commonwealth led to a loss of international contact and cultural exchange.[97]

Because of all this, the Polish Jesuit schools had greatly fallen behind their western European counterparts. The travel diaries kept by the Polish Jesuit Bartłomiej Wąsowski (1617–1687) on his journeys through what are now Czechia, Austria, Germany, the Netherlands, Belgium, England, France, Spain, and Italy between 1650 and 1656 bear witness to what he perceived as the strengths and more advanced state of western Jesuit schools. Among others, he reports of a focus on practical and useful aspects of philosophy and theology, instructions in mathematics, military and civil architecture, the discussion of political topics, an emphasis of contemporary languages, military drills to prepare the students for appearances before royal members, and of course religious practices.[98] Deeply impressed, Wąsowski, who studied mathematics privately after his returned to the Commonwealth,[99] resolved to renew Jesuit mathematical instruction with the further goal of establishing a sort of military academy. He intended it for those students with szlachta background who did not want to continue philosophical

94. Jerzy Paszenda, "Nauczanie architektury w szkołach jezuickich XVIII wieku", in *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, ed. Irena Stasiewicz-Jasiukowa (Kraków: Wydawnictwo WAM, 2004), p. 388.

95. Interestingly enough, the adoption of a (usually petty) noble name was common practice in Poland-Lithuania. This happened particularly often when moving to a remote part of the Commonwealth where it was difficult or impossible to check how proper the claim to nobility was, see Frost, "The Nobility of Poland-Lithuania, 1569–1795", pp. 193–194. A contemporary book by Walerian Nekanda Trepka, *Liber Generationis Plebeanorum (Liber chamorum)*, ed. Włodzimierz Dworzaczek, Julian Bartyś, and Zbigniew Kuchowicz (Wrocław: Zakład Narodowy imienia Ossolińskich, 1963 [1626]), calls out those who were suspected to have wrongly taken on a noble name.

96. Grzebień, "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w.", p. 53; Stanisław Obirek, "The Jesuits and Polish Sarmatianism", in *The Jesuits : Cultures, Sciences, and the Arts. 1540–1773*, ed. John W. O'Malley (Toronto: University of Toronto Press, 1999), pp. 558–559. The Jesuits in question were, however, neither the first nor the last religious men fond of drinking. See, for instance, A. Lynn Martin, "Alcohol and the Clergy in Traditional Europe", in *History Has Many Voices*, ed. Lee Palmer Wandel (Kirksville: Truman State University Press, 2003), pp. 23–39.

97. Bieś, "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności", p. 64.

98. Piechnik, "Studium matematyczne i projekt akademii wojskowej Bartłomieja Wąsowskiego", p. 177–179.

99. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, p. 157.

and theological studies, so that they could remain "continuously in good educational conditions".[100] The academy, however, never came to be, and the mathematics courses that Wąsowski set up separately from philosophy in the Polish Jesuit college in Jarosław in 1673 and 1680 only lasted one and two years, respectively.[101]

A reinvigoration of Jesuit schooling in general and Jesuit mathematical instruction in particular began only in the 1740s when the first of a number of longer-lasting special mathematics classes for future teachers were established. Precipitated by a new generation of Polish Jesuits who had spent some time abroad[102] and the publication of the *Catalogus Praelectionum in Scholis Societatis Jesu Provinciae Polonae*[103] (Lecture catalog in the schools of the Polish province of the Society of Jesus) in 1711, a Polish, more specific update of the *Ratio Studiorum*,[104] specialized courses designed to train future teachers of mathematics were set up at the colleges in Krasnystaw (1728–1732), Lviv (1743–1773), Poznań (1760–1773), Vilnius (1753–1758), Warsaw (1761–1770), Nesvizh (1770–1771), and Polotsk (1772–1773).[105] Unfortunately, no curricula or descriptions of content are known for these courses,[106] but it is sensible to assume that they were guided by the *Catalogus*. It maps out an eight-year-long instruction plan. In the first year, students should hear most of Aristotle's Physics and his Metaphysics, and continue with arithmetics, geometry, geography, astronomy, gnomonics, the calendar, and other topics at the discretion of the teacher. This holds for the second, third, fifth, sixth, and seventh year; in the fourth and eighth, metaphysics and mathematics are not included.[107]

In addition, separate chairs of mathematics were established in major Jesuit colleges, drawing in an increasing number of students again, and new cabinets of physics and mathematics, new experimental laboratories and astronomical observatories were installed.[108] Bednarski even goes so far as to calling this period of time an "epoch in the exact sciences in Poland".[109]

100. "[W] dalszym ciągu w dobrych warunkach wychowawczych", Piechnik, "Studium matematyczne i projekt akademii wojskowej Bartłomieja Wąsowskiego", p. 182.
101. Paszenda, "Nauczanie architektury w szkołach jezuickich XVIII wieku", p. 387.
102. Bednarski, *Upadek i odrodzenie szkół jezuickich w Polsce*, p. 339. Especially Stanisław Solski (1622–1701) and Adam Adamandy Kochański (1631–1700) can be named as representatives of this generation.
103. Reprinted in ibid., pp. 482–488.
104. A description of the *Catalogus*, its curricula, and the daily routine in Polish Jesuit schools can be found in ibid., pp. 103–111.
105. Zofia Pawlikowska-Brożek, "Podręczniki matematyki dla polskich szkół jezuickich", in *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, ed. Irena Stasiewicz-Jasiukowa (Kraków: Wydawnictwo NAM, 2004), p. 246; Paszenda, "Nauczanie architektury w szkołach jezuickich XVIII wieku", p. 386.
106. Paszenda, "Nauczanie architektury w szkołach jezuickich XVIII wieku", p. 386.
107. Bednarski, *Upadek i odrodzenie szkół jezuickich w Polsce*, pp. 482–488.
108. Ibid., p. 339.
109. "*Rok 1752 stanowi naprawdę epokę w dziejach nauk ścisłych w Polsce*". The mentioned year 1752, however,

4.1.4. The Partitions of Poland and the suppression of the Society of Jesus

The successful reinvigoration of Jesuit activity in the early modern sciences in Poland-Lithuania, even an overall "flourishing of the Society in the Commonwealth during the decades before 1773"[110] did not last long, however. 1773, of course, is the year in which Pope Clement XIV issued the suppression of the Society of Jesus,[111] and just one year earlier, the First Partition of Poland heralded the eventual end of the Polish-Lithuanian Commonwealth. Militarily weakened, politically disabled, and economically tattered, the Commonwealth was incapable of forming any kind of opposition when its three neighboring powers Austria, Prussia, and Russia divided the once sovereign state amongst themselves in 1772, 1793, and 1795. The fate of the Polish-Lithuanian Jesuits hence depended on their locations, and to which of the partitioning forces the particular territories fell.

While the Commonwealth ceased to exist with the Third Partition, then entirely broken up, it still prevailed as a Russian-depended entity after the First and Second Partitions. This entity was in need of education and instruction for its youth, so that towards the end of 1773, the Komisja Edukacji Narodowej (KEN, National Education Commission) was created in order to "administer the large network of Jesuit schools",[112] but also supervise schools established by other religious orders.[113] For this purpose, Jesuit assets were to be sold and the proceeds transferred to the KEN, but mismanagement and corruption resulted in a loss of about one third of the expected funds.[114]

Despite the difficult monetary situation, decaying buildings, ruined libraries, and stolen or broken instruments,[115] many Jesuits collaborated in the KEN and continued their work as teachers and rectors or functioned as regular inspectors. Out of the

does not seem to refer to any event in particular. Ibid., pp. 339–340.

110. Butterwick-Pawlikowski, "Before and After Suppression : Jesuits and Former Jesuits in the Polish-Lithuanian Commonwealth, c. 1750–1795", p. 53.

111. See also page 33.

112. Stone, *The Polish-Lithuanian State, 1386–1795*, p. 274.

113. The articles in the recently published Katarzyna Dormus et al., eds., *Komisja Edukacji Narodowej : Kontekst historyczno-pedagogiczny* (Kraków: Wydział Pegagogiczny Uniwersytetu Pedagogicznego im. Komisji Edukacji Narodowej w Krakowie, 2014), offer a good entry-point into sources, secondary literature, and the legacy of the KEN. Particularly of note is the contribution by Beata Topij-Stempińska, "Jezuici i Komisja Edukacji Narodowej w polskiej historiografii XX wieku i początkach XXI wieku", in *Komisja Edukacji Narodowej : Kontekst historyczno-pedagogiczny*, ed. Katarzyna Dormus et al. (Kraków: Wydział Pegagogiczny Uniwersytetu Pedagogicznego im. Komisji Edukacji Narodowej w Krakowie, 2014), discussing the topic of Jesuits and the KEN in Polish historiography of the twentieth and twenty-first centuries.

114. Butterwick-Pawlikowski, "Before and After Suppression : Jesuits and Former Jesuits in the Polish-Lithuanian Commonwealth, c. 1750–1795", p. 60.

115. Ibid.

64 schools governed by the KEN, 38 had been established by the Society of Jesus.[116] Ex-Jesuits were also active in the Towarzystwo do Ksiąg Elementarnych (Society for Elementary Books), an underlying organization of the KEN tasked with writing and publishing new Polish textbooks. It prepared publications for subjects such as mathematics,[117] Latin, history, Polish grammar, moral science, botany, and zoology, but could not find appropriate authors for textbooks in geography, chemistry, and farming.[118] Out of the overall 22 members of the Towarzystwo, ten were former Jesuits.[119]

Following the Second Partition in 1793, the KEN was placed under government supervision and forced to abolish innovations. This effectively cut short its activities, until it ceased to exist entirely one year later.

As to the implementation of the suppression in the annexed territories, the first steps also generally involved a stocktaking of all Jesuit properties and possessions. Clement XIV had intended for them to fall to the church, but many secular rulers turned them into state property instead, as did Austrian Empress Maria Theresia (1717–1780, reign 1740–1780).[120] In contrast to other kingdoms such as Portugal and Spain, which banished and deported members of the Society of Jesus from their territories, Austrian Jesuits were allowed to stay and often even remained in their prior positions.[121]

Prussia also went with a different approach to the bull. Having conquered Catholic Silesia in 1741 and hence bringing the Catholic population up from four to 16 percent, King Frederick the Great (1712–1786, reign 1740–1786) realized that the existing Jesuit educational system, even if dated, was without alternative.[122] In an attempt to both modernize the Silesian Jesuit schools and break up lingering sympathies towards the Austrian Habsburg, the previous rulers, Frederick brought in highly qualified French

116. Stone, *The Polish-Lithuanian State, 1386–1795*, pp. 313.

117. Zofia Pawlikowska-Brożek, "Matematyka w okresie reform szkolnych przed lat dwustu", *Roczniki Polskiego Towarzystwa Matematycznego. Seria 2: Wiadomości Matematyczne* 24, no. 01 (1982): pp. 98–104, discusses some select mathematical writings.

118. Stone, *The Polish-Lithuanian State, 1386–1795*, pp. 275, 313.

119. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 294.

120. Friedrich, *Die Jesuiten*, pp. 547–548.

121. Bieś, "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności", pp. 76–77. Paul Shore, "Ex-Jesuits in the East Habsburg Lands, Silesia and Poland", in *The Jesuit Suppression in Global Context : Causes, Events, and Consequences*, ed. Jeffrey D. Burson and Jonathan Wright (Cambridge University Press, 2015), provides insight into the fates of Jesuit scholars in Austrian Hungary and touches upon biographies of several Jesuits working in the early modern sciences (pp. 230–231, 236, 238–240). See also Paul Shore, "Enduring the Deluge : Hungarian Jesuit Astronomers from Suppression to Restoration", in *Jesuit Survival and Restoration : A Global History, 1773–1900*, ed. Robert A. Maryks and Jonathan Wright (Leiden: Brill, 2015), pp. 148–161.

122. Roland Gehrke, "Die Aufhebung des Jesuitenordens und ihre Folgen für die Leopoldina", in *Die tolerierte Universität : 300 Jahre Universität Breslau 1702 bis 2002*, ed. Norbert Conrads (Stuttgart: Franz Steiner Verlag, 2004), pp. 229–231.

Jesuits to teach in Wrocław.[123] When the suppression of the Society was issued, he delayed its promulgation in Silesia until 1776; in the new eastern territories just acquired from the First Partition of Poland, he dissolved the order only in 1780. At that point, Jesuit properties passed over to Prussia, and the *Institutum Litterarium Regium* (Royal Institute of Letters) was founded as a framework within which the Jesuits were to continue their educational work (again 1776 in Silesia, 1780 in the eastern territories). After 20 years of activity, the *Institutum* was closed down in 1800, ending ex-Jesuit activities in Prussian education.[124]

The Russian Empress Catherine the Great, finally, also sought to keep Jesuit schooling functional in her territories and prohibited the suppression from being executed.[125] Unlike in Prussia, however, the Society technically retained its *status ante quo* in Russia, never to be disbanded or organized in a different way. Under Catherine's rule, the Russian Jesuits continued to create precedents which the Pope was eventually forced to sanction, such as permitting them to accept confrères from other places in 1776, allowing them to admit noviciates in 1778, and even officially acknowledging the existence of a Russian Society of Jesus in 1801.[126]

The principal areas of activity for the Russian Jesuits were pastoral care and schooling; they saw the foundation of several new colleges, and the elevation of the Polotsk college to a university in 1812.[127] Due to the influx of foreign ex-Jesuits, the Russian Society was very multinational, with half of it originating from all over Europe.[128] Its focus, however, lay always on restoration instead of advancement.[129]

The continued, papally tolerated existence of the Society in Russia gave other ex-Jesuits the hope of a possible future restoration of the order. It began to be clear, in fact, that such a restoration would be based on the Russian Jesuits.[130] With the political climate favorable, the Society of Jesus was eventually rehabilitated by Pope Pius VII (1742–1823, papacy 1800–1823) in 1814. By this point, however, the situation of the

123. Ibid., p. 231.
124. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, pp. 230, 545.
125. For a longer account of the history of the Society of Jesus on Russian grounds, see Marek Inglot, "The Society of Jesus in the Russian Empire (1772–1820) and the Restoration of the Order", in *Jesuit Survival and Restoration : A Global History, 1773–1900*, ed. Robert A. Maryks and Jonathan Wright (Leiden: Brill, 2015), pp. 67–82.
126. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, pp. 542–543.
127. On Polotsk in particular, see Irena Kadulska, "The Połock Academy (1812–1820) : An Example of the Society of Jesus's Endurance", in *Jesuit Survival and Restoration : A Global History, 1773–1900*, ed. Robert A. Maryks and Jonathan Wright (Leiden: Brill, 2015), pp. 83–98.
128. Grzebień et al., *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*, p. 543.
129. Friedrich, *Die Jesuiten*, speaks of "Abschottung statt Ausstrahlung", seclusion instead of emanation, on p. 561.
130. Ibid., pp. 561–563.

Jesuits in Russia had taken a turn for the worse. Their opposition to the educational and religious politics of Emperor Alexander I (1777–1825, reign 1801–1825) resulted in them falling from his grace, and with the order restored, "Russia lost its leverage as the Jesuits' sole protector".[131] After first expulsions from St Petersburg and Moscow in 1815, Alexander I banned the Society from the rest of his empire in 1820.

4.2. Showcasing the Jesuit Science Network II: Data evaluations

As I have established in Section 3.7.3, the showcasing of the Jesuit Science Network consists of two parts: a descriptive presentation of the project website jesuitscience.net on one hand, and data-driven evaluations on the basis of the underlying SQL database on the other. For the following, I only consider data from Bogdan Lisiak's *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny* and analyze it with respect to

- the distribution of subjects among the sampled scholars, the categories Career and Education, and over time, see Section 4.2.2,
- Polish-Lithuanian Jesuit centers of entry and activity in the early modern sciences, see Section 4.2.3,
- and student-teacher relationships among Polish-Lithuanian Jesuits, see Section 4.2.4.

The purpose of these evaluations, however, is not to produce substantial hypotheses or conclusions, but to provide examples of data exploration made possible by the Jesuit Science Network infrastructure. While it will be tempting to extrapolate some of the presented results into interpretations, they should merely be taken as indications of points that would be worthwhile of further investigation. In select cases, I will explain why the results have to be taken with a grain of salt.

Lisiak's bio-bibliographical study, first introduced in Section 3.2 and repeatedly mentioned throughout this thesis, contains the biographies of 37 Jesuits from the Polish-Lithuanian Commonwealth dealing with the "nauki ścisłe", or exact sciences, between the sixteenth and nineteenth century. Out of these 37, I have entered 36 into the JSN; the odd one out, Aleksander Gromadzki, was excluded due to his very late birth date of

131. Daniel L. Schlafly, Jr, "The Post-Suppression Society of Jesus in the United States and Russia: Two Unlikely Settings", in *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, ed. John O'Malley (Toronto: University of Toronto Press, 2006), p. 778.

1833.[132] Because of that, he falls into the scope of the reestablished Society of Jesus and is of no relevance for my work. The other notable special case is Franciszek Ksawery Bohusz (1746–1820),[133] the only entry without any mention of activity in the early modern sciences in his biography; however, he is credited as the author of several architectural writings, and hence included in the JSN.

A complete list list of names from Lisiak can be found in Table A.1 in Appendix A.3. In addition to linking to the respective data sheets on the JSN website, it also indicates which of the scholars are on the Bliard* list[134] and which have an entry in the *Diccionario Histórico de la Compañía de Jesús*.

4.2.1. Approach and attribution

The following evaluations are exclusively concerned with the 36 Jesuits from Lisiak's study as defined above. The necessary data is extracted from the SQL database in the form of CSV files, edited, and further processed; only aspects with *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny* as their reference are considered for the queries. The tables and visualizations in Figures 4.2 to 4.10 on pages 172 to 175, 177, 178, 180, 182 and 184 were generated with the data visualization software Tableau. The maps in Figures 4.4, 4.9 and 4.10 on pages 174, 182 and 184 are copyrighted to OpenStreetMap contributors.[135] The visualization in Figure 4.11 on page 185 was generated with Graphviz.

4.2.2. Subject distribution, activity over time, and activity in mathematics

With regards to the subjects that Jesuit scholars engaged in during the early modern period, jesuitscience.net provides the possibility to explore their entire range in a comprehensive list, as well as allows to dive right into the data set via the *what* search. While the results of this search can then be further refined by applying additional filters, they do not allow to easily find out about the overall amount of scholars associated with

132. Gromadzki, who mostly occupied himself with astronomy and astronomical observations, mathematics, and physics, died in 1913. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, pp. 54–56.
133. Ibid., pp. 25–28.
134. Pierre Bliard, editor of volume X of Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus*, compiled a categorization of the bibliographical entries from the first nine volumes into five groups, see page 66. In Section 3.6, I then defined Bliard* as those names from the initial Bliard list that are of interest for the JSN.
135. See `http://www.openstreetmap.org/copyright`, accessed 09/18/2017.

a particular subject.[136] However, this kind of information can be comfortably gleaned from the underlying database.

Figure 4.2 on page 172 thus shows a listing of all the subjects treated by Lisiak's Jesuits (second column) along with the distinct numbers of those Jesuits associated with these subjects (third through fifth columns).[137] The tally was taken without spatial restriction; for the third column, aspects from all categories were searched, for the fourth column, only Education aspects, and for the fifth column, only Career aspects. Please note that the Overall column is not necessarily the sum of the Education and Career column: Miscellaneous aspects might also contain suitable information and hence count towards the Overall number, but are naturally omitted for the Education and Career number. The first column additionally introduces subject groups, defined in order to aggregate similar topics, reduce compartmentalizing, and allow for a better overview:

Architecture* Architecture, civil architecture, military architecture

Astronomy* Astronomical facilities, astronomical observations, astronomical observatory, astronomy

History* Church history, history

Languages & Classics French, German, grammar, Greek, Hebrew, hieroglyphs, poetics, poetry, rhetoric, syntax

Law* Canon law, law

Mathematics* Higher mathematics, mathematics

Theology* Controversial theology, dogmatic theology, moral theology, polemic theology, positive theology, scholastic theology, theology

I will be using these groups in the subsequent evaluations, as well.

Studying the Overall column in Figure 4.2 with regards to particular subjects, the three with the largest amount of distinct associations are theology, philosophy, and mathematics. As each Jesuit novice had to complete courses in the first two in order to proceed to higher education, their rank does not come as a surprise. The high number for mathematics in turn reveals it to be the most common early modern science among

136. It is not impossible to do this merely with the help of the jesuitscience.net search, but it would require some rather extensive manual noting, sorting, and counting of names and subjects.

137. Distinct means that repeat occurrences of a subject in different aspects of the same person were not summed up.

Lisiak's Jesuits, followed by physics, astronomy*, and architecture* only by a clear margin. Most of the other subjects amount to less than five associated scholars, with only grammar, poetics, rhetoric, and syntax rising above ten. The reason for this becomes clear when proceeding to a comparison between the Education and Career columns.

Here, as mentioned above, theology and philosophy feature the highest numbers concerning Education, but have distinctly lower ones concerning Career. In contrast, the subjects from the Language & Classics grouping barely appear in the Education column, and instead show up prominently in the Career column, even surpassing theology. The reason for this is that while completing their own training, Jesuits had to take up teaching themselves, usually of easier topics such as grammar, poetics, rhetoric, and syntax. A particularity to Poland-Lithuania, this teaching period also included the so called Infima, the first class in Commonwealth schools.

In the Career column, however, mathematics has the highest amount of associated Jesuits, with physics, architecture*, and astronomy* far behind. In order to understand this finding better, I picked mathematics for further investigation. Narrowing down the scope of the query in this way allows for a meaningful inclusion of dates and results in Figure 4.3 on page 173. In addition, I have formulated a geographic restriction so that only aspects with places from the Polish-Lithuanian Commonwealth are considered.

Figure 4.3 now shows the numbers of Polish-Lithuanian Jesuits associated with mathematics broken down to the three aspect categories Career, Education, and Miscellaneous. The count was taken per year (date of beginning) and place (restricted to places in the Commonwealth), and aggregated over decades (ranging from 1610 to 1770). Up until 1680, the bars display low to moderate activity,[138] followed by a complete disappearance of mathematics for fifty years. The subject then finally returns in the 1730s, shows exceptional growth in the 1740s and 1750s, and maintains the high numbers in the 1760s and 1770s regarding both education and career.

This strongly reminds of the development described in Section 4.1.3, the overall crisis of Jesuit schooling in seventeenth century Poland-Lithuania and the subsequent attempts at restoring a high level of instructions particularly in the early modern sciences; the data at hand suggests the success of these attempts.

138. The spike in the 1630s is due to two Jesuits, Jakub Święcius (1591–1663) and especially Oswald Krüger (1598–1655). The latter was moved around a lot while teaching mathematics during that time.

4.2.3. Visualizing Jesuit centers of entry and activity in the Commonwealth

The focus of this section lies on the centers of Jesuit entry and activity in the Polish-Lithuanian Commonwealth. This involves an evaluation of the Education and Career aspects in terms of the associated subjects and their geographical information, insofar available. Figure 4.4 now maps out the places of birth versus the places of entry just like in Section 5.5.

Without much surprise, the map reveals Kraków, still an important Jesuit hub despite the antagonism from the Kraków Academy, and Vilnius, eastern intellectual Jesuit center and university, as the two main points of attraction. It is striking, however, that all the other places of entry in the Commonwealth—Daugavpils, Nesvizh, and Ostroh—are located in the eastern parts and each appear only once, whereas the following visualizations will show that there were indeed other, decidedly more active Jesuit colleges in other regions of the Commonwealth, as well.

To provide a complete picture, I have compiled four tables with all the relevant data in addition to visualizing it on a map. The tables show which places are associated with which subjects for both the Education and the Career category, with one set grouped by place and the other grouped by subject grouping. The tables hence essentially display the same data, but provide two different views on it. Figures 4.5 and 4.7 on pages 175 and 178 contain the tables for Education, Figures 4.6 and 4.8 on pages 177 and 180 those for Career. In all tables, and maps Figures 4.9a and 4.9b, subjects from the early modern sciences are marked in green.

When now comparing the ratio of Non-Commonwealth to Commonwealth places in Figures 4.5 and 4.6, it appears that the Polish-Lithuanian Jesuits spent much more time abroad for their education than they did for their career. Figure 4.9 on page 182 provides a clear geographical visualization of this. Interestingly enough, while Kraków turned out to be one of the centers of entry for prospective members of the Society, the tables show that it played only a minor role for their further training and work. Looking up the fundamental subjects philosophy and theology in the tables grouped by subject grouping, the largest numbers in Education are next to Kalisz and Vilnius, and Vilnius and Poznań by far, respectively. Concerning the Career category, Kraków is only mentioned once in conjunction with theology*. This observation certainly hints at the devastating effect that the Kraków Academy had on the intellectual development of the Jesuit college, but the underlying sample is too small for a reliable conclusion.

With regards to subjects from the early modern sciences, Figures 4.5 and 4.7 show that Polish-Lithuanian Jesuits received most of their instruction in the Commonwealth (with

Vilnius, Warsaw, and Kalisz being the most notable centers), but also traveled to Vienna, Paris, Rome, Freiburg im Breisgau, and Graz especially for mathematics and astronomy*. Their later career then unfolded predominantly in Poland-Lithuania, see the mapping in Figure 4.10 on page 184. Next to mathematics*, architecture* accounts for the most mentions, followed by physics and astronomy*. Again, Vilnius appears as a center of activity in the data, and while Warsaw is strong with mathematics* and architecture*, the previously not occurring Jarosław combines several of the less named subjects such as hydrostatics, mechanics, and statics. The other places are also mainly associated with mathematics*.

Initially, the appearance of Jarosław along with the place's diverse selection of associated subjects seems quite remarkable, but searching for it in the Jesuit Science Network quickly reveals that this diversity is due to one particular scholar. The Polish-Lithuanian Jesuit Faustyn Grodzicki (1710–1787) worked in Jarosław as a teacher of mathematics, geometry, mechanics, statics, hydrostatics, perspective, civil architecture, military architecture, and tactics (along with the not involved polemic theology) between 1749–1750. Although this knowledge now puts the visualization into perspective, it still gives rise to the question how one Jesuit could teach so many different subjects at the same time in this rather remote location, quite possibly a question worthwhile of further research.

4.2.4. Teacher-student relationships

For the final evaluation based on the sample from Bogdan Lisiak's study and the corresponding data in the Jesuit Science Network, I would like to present a graphical visualization of relationship information. As I have mentioned earlier, Lisiak's work is the only among the sources of the JSN that consistently makes note of interpersonal relationships. The biography on Tomasz Żebrowski (1714–1758), for example, reports that he studied mathematics, astronomy, and architecture under the instruction of the German Jesuit Joseph Stepling (1716–1778), and also relates that he initiated a scholarly exchange with several Jesuit mathematicians, among them Rudjer Bošković (1711–1787) and Maximilian Hell (1720–1792).[139] One of the relationships given for Adam Adamandy Kochański (1631–1700) concerns his positions as court missionary and royal mathematician under the Polish King John III Sobieski (1629–1696); it is also mentioned that Kochański had to leave Prague due to misunderstandings with the Czech Jesuits, but unfortunately no further names or information follow.[140] Tomasz Siekierzyński (1720–1774) finally

139. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, pp. 162.
140. Ibid., pp. 69–70.

belongs to one of the relation-richest entries in the study, with four teachers and three students of himself given by name.[141]

This account shall merely hint at the plethora of people and their relationships covered by Lisiak. It furthermore explains why I chose one particular type of relationship—the connection between teacher and student—for the following Figure 4.11 on page 185, as one image containing everything would become outright unreadable. In the figure, names of Jesuit scholars are connected with arrows that indicate the direction of instruction.[142] Those names in boxes with solid borders belong to the sample, while those with dashed borders are only mentioned by Lisiak, and their biographies come from a different source.

I would also like to point out that Figure 4.11 is no network analysis, but a network visualization. Even so, it has more merit than just being a graphical representation of select aspects of Lisiak's study; it rather helps to understand the bigger picture, to see how far-reaching the connections between the Polish-Lithuanian Jesuits actually were, and to open up new research questions.

The above introduced Żebrowski and Siekierzyński, for example, both turn out to have been students of Stepling. A quick look in the JSN then reveals that Siekierzyński was taught mathematics, architecture, and physics by Stepling in Prague between 1750 and 1752, and that Żebrowski studied mathematics, astronomy, and architecture under Stepling also in Prague between 1750 and 1752. The two students are therefore likely to have known each other, although Lisiak does not make any mention of that. What is more, they also could have known Jan Bohomolec (1724–1795) and Marcin Poczobut (1724–1795), similarly students of Stepling in Prague where he taught from 1751 to 1778, albeit no specific period of time is given for Bohomolec's presence, and Poczobut's training took place between 1754 and 1756. Nonetheless, this establishes Stepling as a long-ranging fixture in Prague under whose guidance these particular four Jesuits learned about mathematics, astronomy, architecture, and physics, making a further study of their paths, their work, and possible connections to their teacher and each other worthwhile.

While Żebrowski, Siekierzyński, Poczobut, and especially Bohomolec are thus all part of one bigger cluster, Figure 4.11 also shows disconnected clusters around Charles Malapert (1580–1630), Oswald Krüger (1598–1655), Stanisław Solski (1622–1701), Jan

141. All but one of the students are also included in the JSN. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*, p. 116.

142. As mentioned earlier, the PDR data model makes a distinction between relationships of the form 'A taught B' and 'B studied under A', allowing for a most precise rendering of the inherent structure of the data sources. In order to enhance readability, both were equated and simplified to 'A taught B' for Figure 4.11.

Mikołaj Smogulecki (1610–1656), and Franciszek Narwojsz (1742–1819). Narwojsz is only disconnected in terms of student-teacher relationships, but connected with Poczobut and his student Andrzej Strzecki (1737–1797) in terms of collaboration; according to Lisiak, together the three of them held a special geometry course in Vilnius in 1773. The other four, however, are truly disconnected from the rest of the sample in all kinds of relationships. They still exhibit one common characteristic in their dates of life and death: being active mostly during the seventeenth century, they came generations earlier than any of the Jesuits from the previous paragraph. The crisis of Jesuit schooling in Poland-Lithuania during that period and the crisis of the Commonwealth itself come to mind again, and the lack of extensive teacher-student relationships could be read as indicative for this context.

Subject groups	Subject	Overall	Education	Career
Architecture*	Architecture	6		4
	Civil architecture	3		3
	Military architecture	2		2
	Total	**11**		**9**
Arithmetic		**1**		**1**
Astronomy*	Astronomical facilities	1		
	Astronomical observations	4	1	2
	Astronomical observatory	3		
	Astronomy	11	8	3
	Total	**19**	**9**	**5**
Botany & Zoology	Botany	1		1
	Zoology	1		1
	Total	**2**		**2**
Calendars		**1**	**1**	
Ethics		**2**		**2**
Geometry		**3**		**2**
History*	Church history	1		1
	History	1		1
	Total	**2**		**2**
Hydrostatics		**1**		**1**
Infima		**8**		**8**
Languages & Classics	French	2		2
	German	1		1
	Grammar	13		13
	Greek	2		2
	Hebrew	4		4
	Hieroglyphs	1		1
	Poetics	15		15
	Poetry	1		1
	Rhetoric	15	2	14
	Syntax	11		11
	Total	**65**	**2**	**64**
Law*	Canon law	3		3
	Law	1	1	
	Total	**4**	**1**	**3**
Logic		**2**		**2**
Mathematics*	Higher mathematics	1		1
	Mathematics	31	17	26
	Total	**32**	**17**	**27**
Mechanics		**4**	**1**	**3**
Metaphysics		**2**		**2**
Natural and exact sciences*	Exact sciences	2	1	1
	Natural and exact sciences	1		
	Total	**3**	**1**	**1**
Natural history		**1**		**1**
Perspective		**1**		**1**
Philosophy		**36**	**34**	**16**
Physics		**12**	**6**	**6**
Proper instrument use		**1**	**1**	
Statics		**1**		**1**
Tactics		**1**		**1**
Theology*	Controversial theology	1		1
	Dogmatic theology	1		1
	Moral theology	7		7
	Polemic theology	2		2
	Positive theology	2		2
	Scholastic theology	5		5
	Theology	35	35	2
	Total	**53**	**35**	**20**

Figure 4.2.: Distinct numbers of Polish-Lithuanian Jesuits associated with a subject. Subjects from the early modern sciences marked in green.

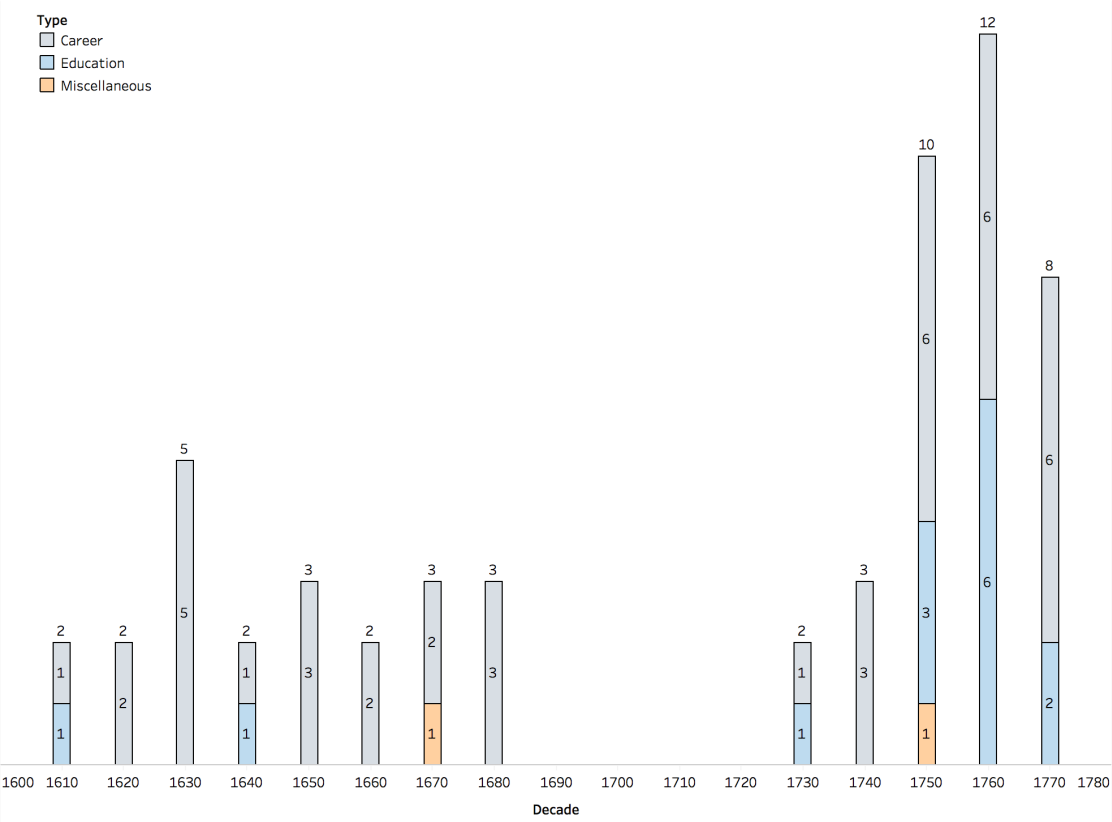


Figure 4.3.: Polish-Lithuanian activity in mathematics. Count taken per year and place (restricted to the Commonwealth) and aggregated over decades.

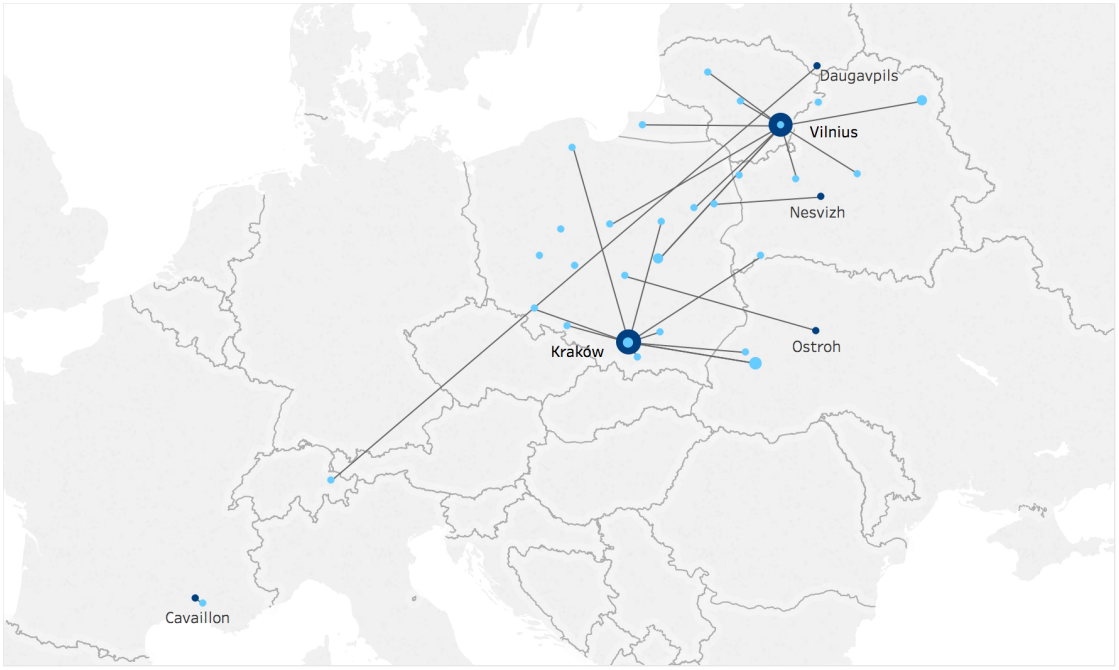


Figure 4.4.: Places of birth (light blue dots) versus places of entry (dark blue dots) for the Polish-Lithuanian Jesuits. Dot size scaled with the amount of people who were and entered at this place, respectively.

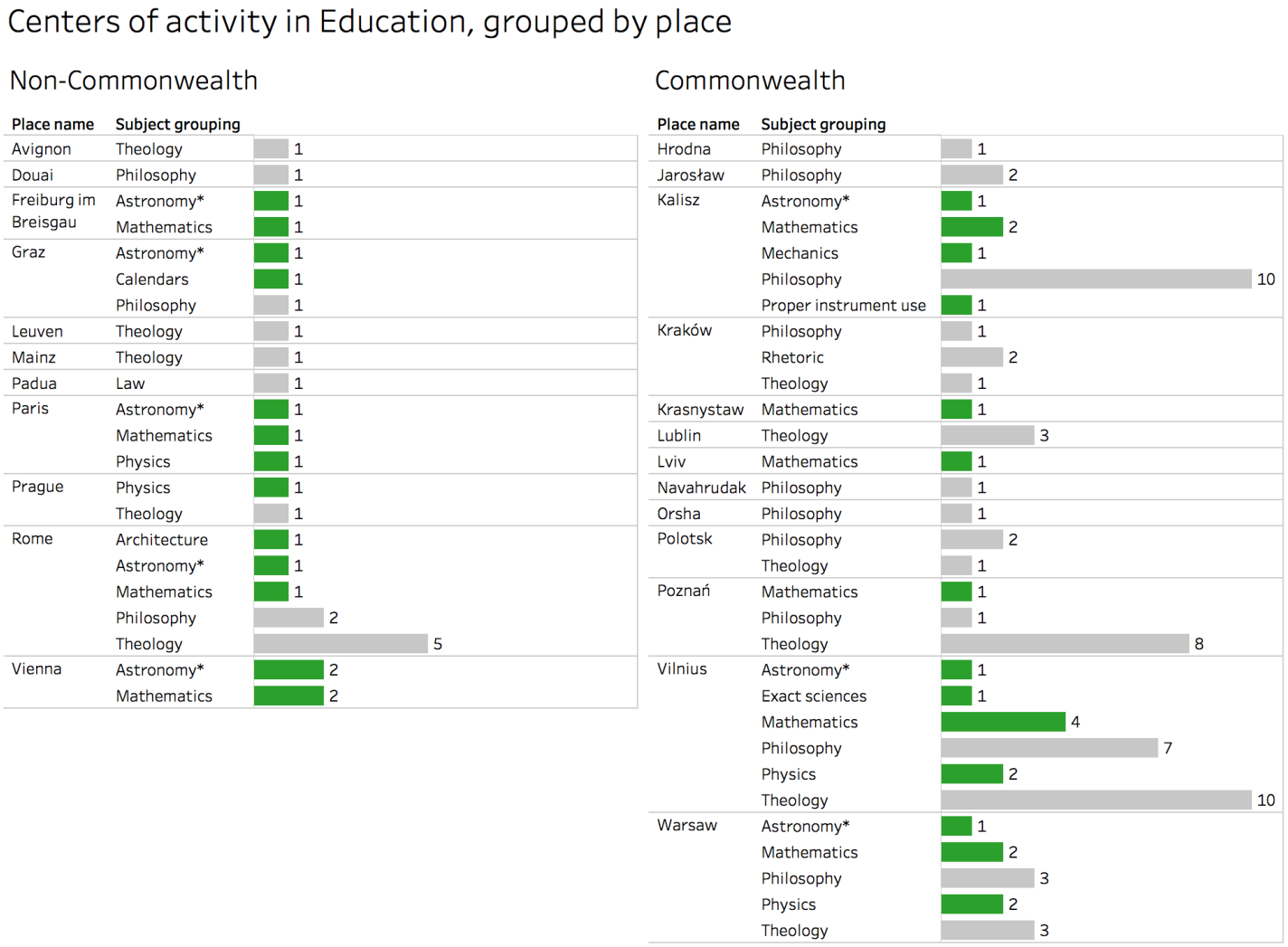


Figure 4.5.: Jesuit centers of activity in Education, grouped by place, overall numbers. Subjects from the early modern sciences marked in green.

Centers of activity in Career, grouped by place

Non-Commonwealth

Place name	Subject grouping	
Grenoble	Languages & Classics	2
Istanbul	Languages & Classics	1
	Mathematics*	1
Navarre	Mathematics*	1
Pont-à-Mousson	Philosophy	1
Prague	Mathematics*	1
Vesoul	Languages & Classics	1

Commonwealth

Place name	Subject grouping	
Braniewo	Languages & Classics	1
Bydgoszcz	Languages & Classics	2
Daugavpils	Languages & Classics	3
Gdańsk	Languages & Classics	1
Hrodna	Infima	2
	Languages & Classics	2
Ilūkste	Infima	1
	Languages & Classics	4
Jarosław	Architecture*	2
	Geometry	1
	Hydrostatics	1
	Languages & Classics	6
	Mathematics*	1
	Mechanics	1
	Perspective	1
	Philosophy	1
	Statics	1
	Tactics	1
	Theology*	1
Kalisz	Ethics	1
	Mathematics*	1
Kaunas	Languages & Classics	1

Commonwealth (cont.)

Place name	Subject grouping	
Kraków	Theology*	1
Krasnystaw	Mathematics*	2
	Metaphysics	1
	Physics	1
Kražiai	Languages & Classics	1
	Logic	1
	Mathematics*	1
	Philosophy	1
Kremenets	Theology*	1
Krosno	Infima	1
	Languages & Classics	1
Łęczyca	Languages & Classics	1
Lublin	Canon law	1
	Mathematics*	2
	Philosophy	2
	Theology*	2
Lutsk	Logic	1
	Theology*	1
Lviv	Architecture*	1
	Astronomy*	1
	History*	1
	Languages & Classics	3
	Mathematics*	2
	Philosophy	3
	Theology*	3
Mińsk	Infima	1
Navahrudak	Physics	1
Nesvizh	Infima	1
	Languages & Classics	1
	Theology*	1
Ostroh	Theology*	1

Centers of activity in Career, grouped by place (cont.)

Commonwealth (cont. 2)

Place name	Subject grouping	
Polotsk	Botany & Zoology	2
	Infima	1
	Languages & Classics	6
	Mathematics*	1
	Mechanics	1
	Philosophy	1
	Physics	1
Poznań	Architecture*	1
	Languages & Classics	6
	Mathematics*	2
	Philosophy	1
	Physics	1
	Theology*	1
Przemyśl	Languages & Classics	1
	Theology*	2
Sambir	Infima	1
Slutsk	History*	1
	Languages & Classics	3
Ternopil	Natural history	1
	Philosophy	1
Toruń	Languages & Classics	3
Vilnius	Astronomy*	2
	Canon law	1
	Ethics	1
	Exact sciences	1
	Languages & Classics	5
	Mathematics*	8
	Metaphysics	1
	Philosophy	1
	Physics	1
	Theology*	4

Commonwealth (cont. 3)

Place name	Subject grouping	
Warsaw	Architecture*	3
	Astronomy*	1
	Canon law	1
	Geometry	1
	Languages & Classics	6
	Mathematics*	3
	Mechanics	1
	Philosophy	4
	Physics	1
	Theology*	3
Wrocław	Languages & Classics	1
Zhytomyr	Languages & Classics	1
Žodziški	Languages & Classics	1

Figure 4.6.: Jesuit centers of activity in Career, grouped by place, overall numbers. Subjects from the early modern sciences marked in green.

Figure 4.7.: Jesuit centers of activity in Education, grouped by subject groups, overall numbers.

Centers of activity in Career, grouped by subject grouping

Non-Commonwealth

Subject grouping	Place name	
Languages & Classics	Grenoble	2
	Istanbul	1
	Vesoul	1
Mathematics*	Istanbul	1
	Navarre	1
	Prague	1
Philosophy	Pont-à-Mousson	1

Commonwealth

Subject grouping	Place name	
Architecture*	Jarosław	2
	Lviv	1
	Poznań	1
	Warsaw	3
Astronomy*	Lviv	1
	Vilnius	2
	Warsaw	1
Botany & Zoology	Polotsk	2
Canon law	Lublin	1
	Vilnius	1
	Warsaw	1
Ethics	Kalisz	1
	Vilnius	1
Exact sciences	Vilnius	1
Geometry	Jarosław	1
	Warsaw	1
History*	Lviv	1
	Slutsk	1
Hydrostatics	Jarosław	1

Commonwealth (cont.)

Subject grouping	Place name	
Infima	Hrodna	2
	Ilūkste	1
	Krosno	1
	Mińsk	1
	Nesvizh	1
	Polotsk	1
	Sambir	1
Languages & Classics	Braniewo	1
	Bydgoszcz	2
	Daugavpils	3
	Gdańsk	1
	Hrodna	2
	Ilūkste	4
	Jarosław	6
	Kaunas	1
	Kražiai	1
	Krosno	1
	Łęczyca	1
	Lviv	3
	Nesvizh	1
	Polotsk	6
	Poznań	6
	Przemyśl	1
	Slutsk	3
	Toruń	3
	Vilnius	5
	Warsaw	6
	Wrocław	1
	Zhytomyr	1
	Žodziški	1
Logic	Kražiai	1
	Lutsk	1

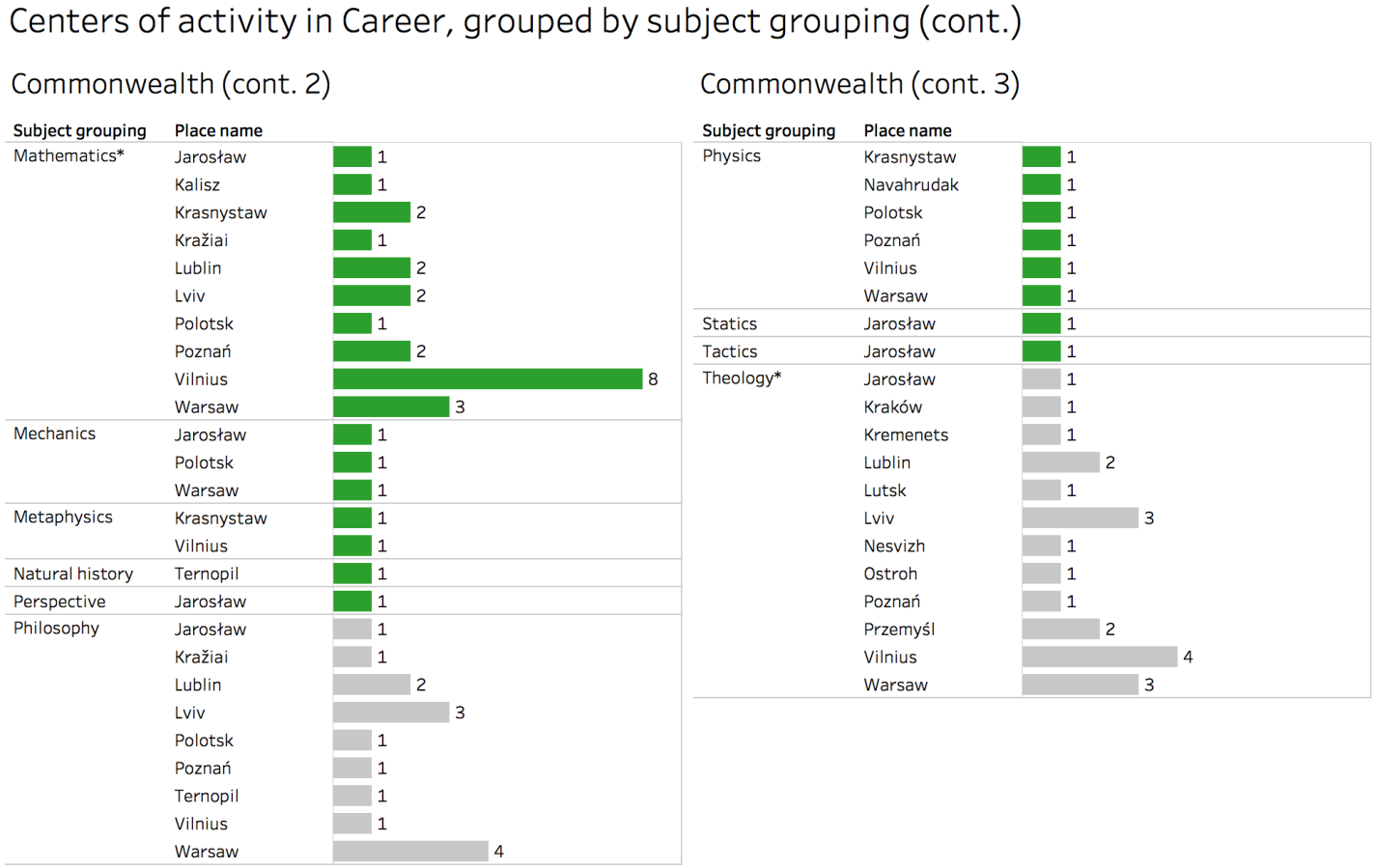
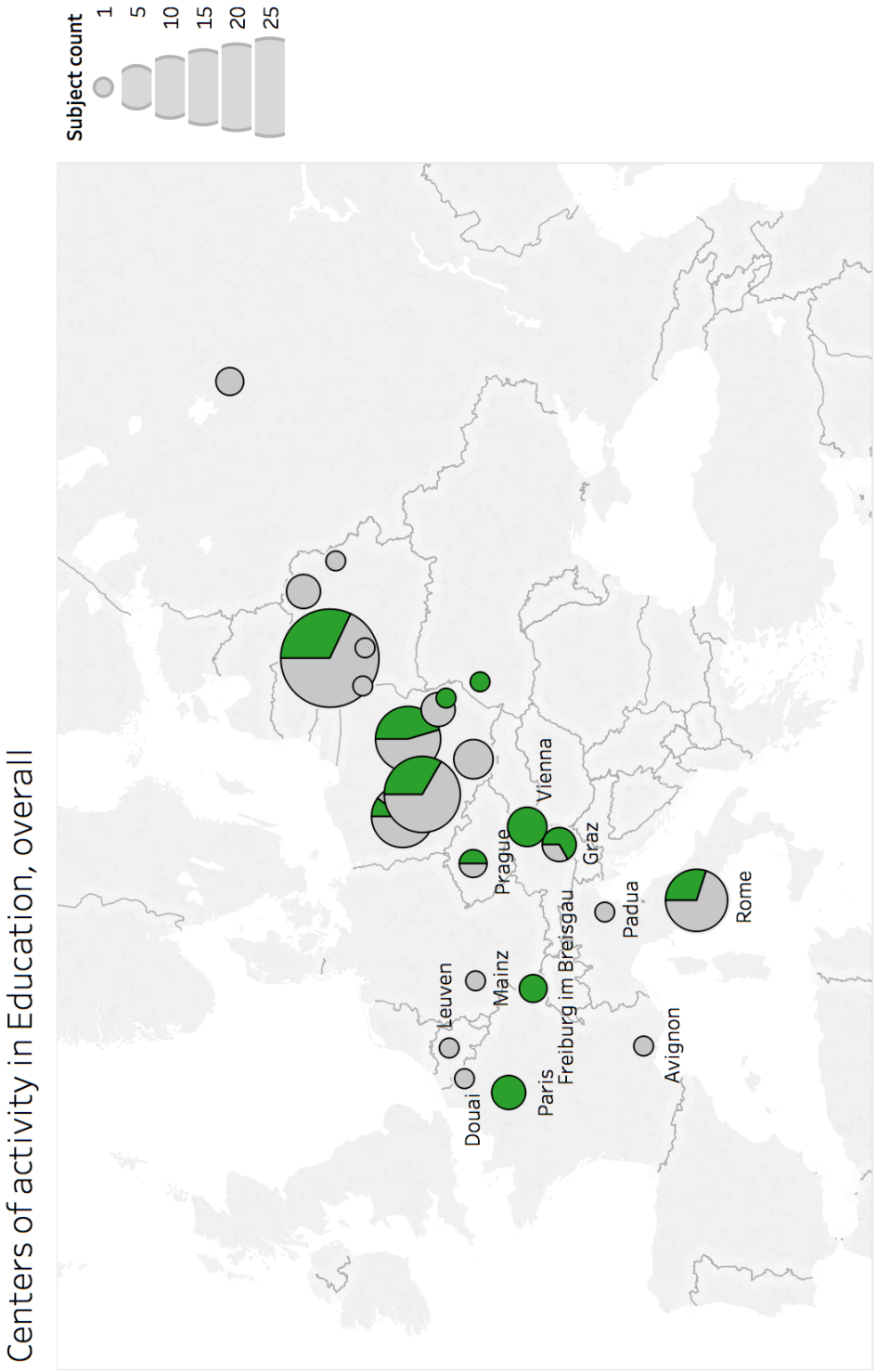
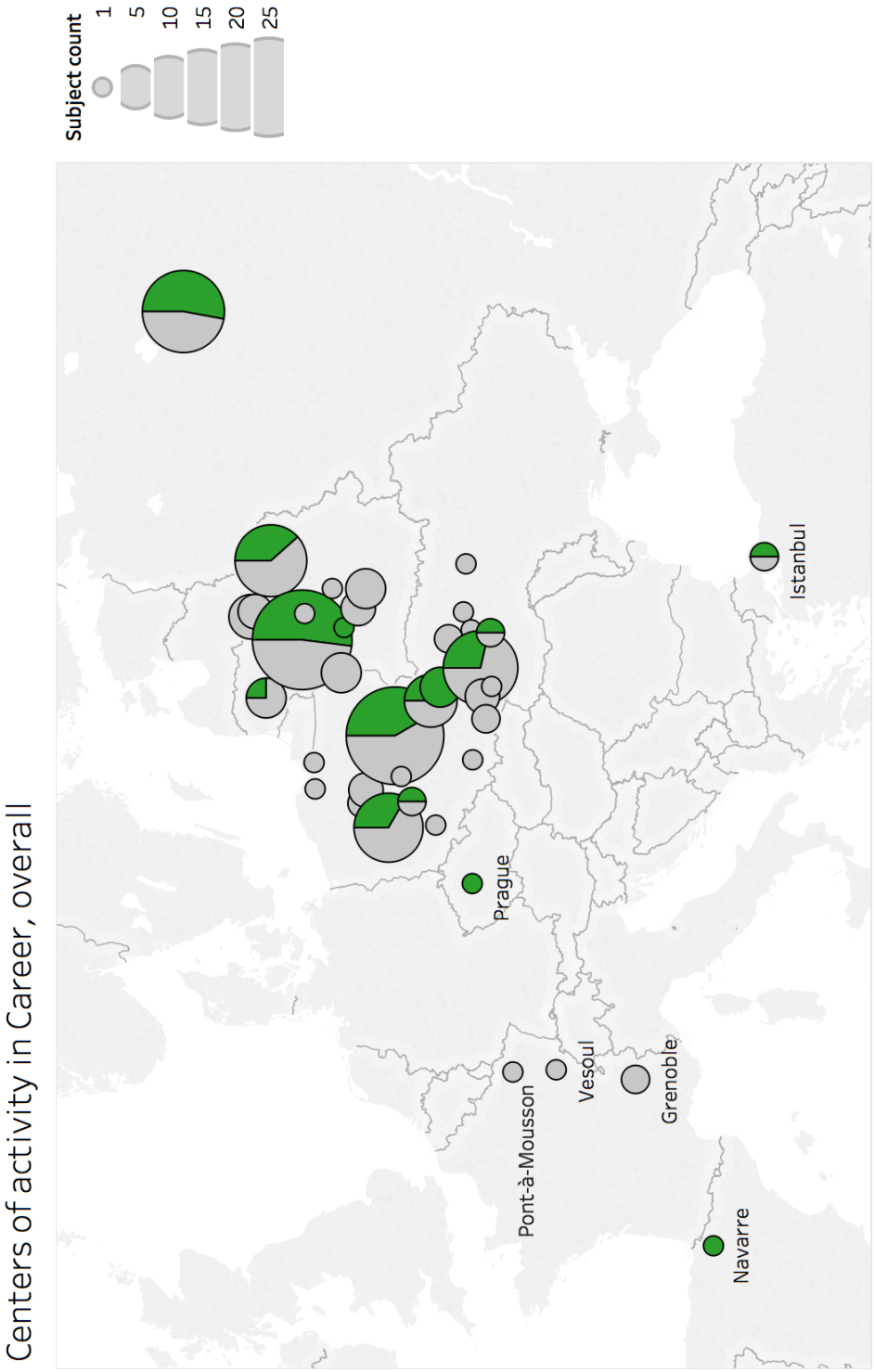


Figure 4.8.: Jesuit centers of activity in Career, grouped by subject groups, overall numbers. Subjects from the early modern sciences marked in green.

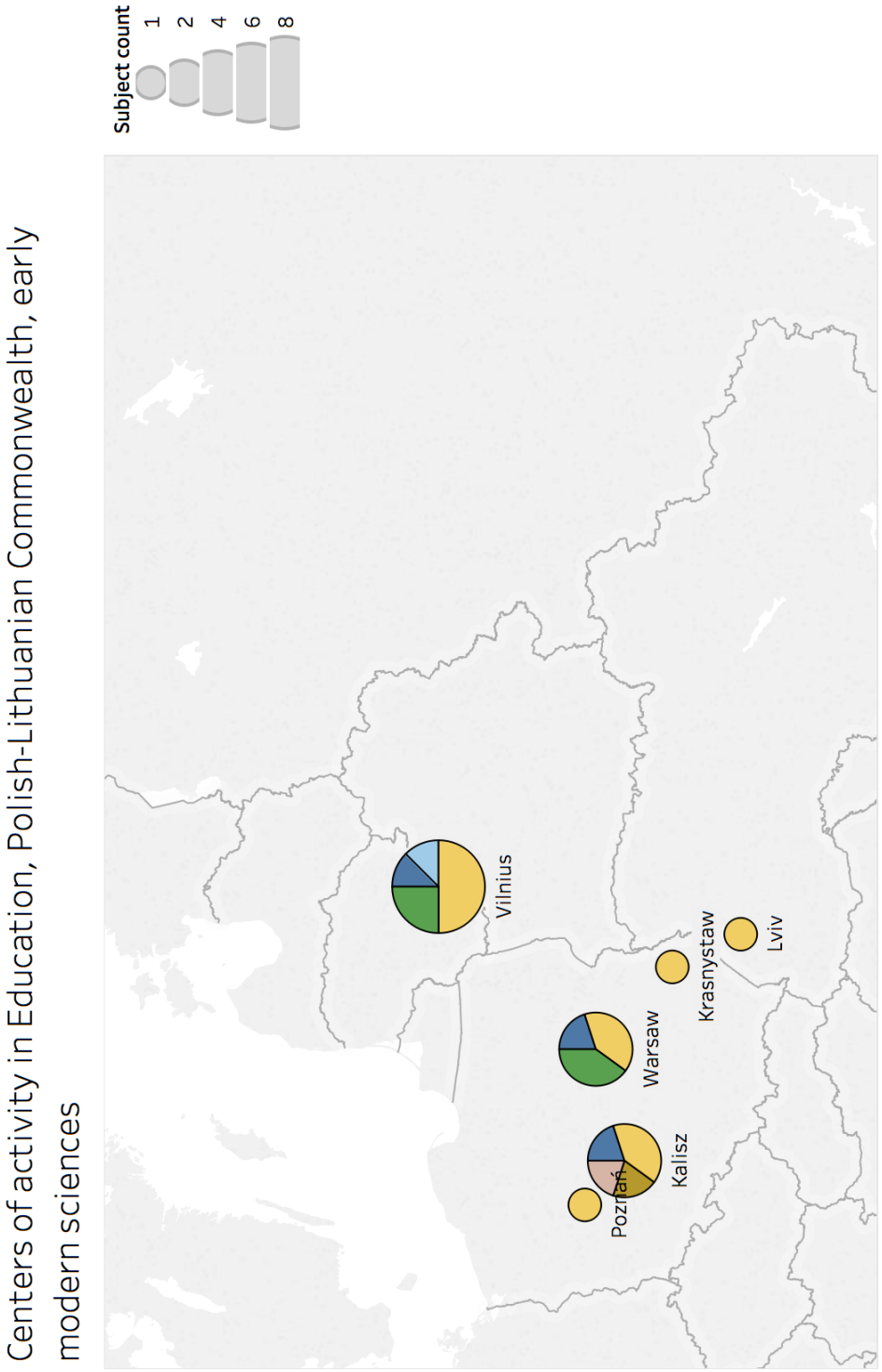

Centers of activity in Education, overall
Subject count
1
5
10
15
20
25
Vienna
Prague
Graz
Padua
Rome
Mainz
Leuven
Freiburg im Breisgau
Paris
Douai
Avignon

(a) Education

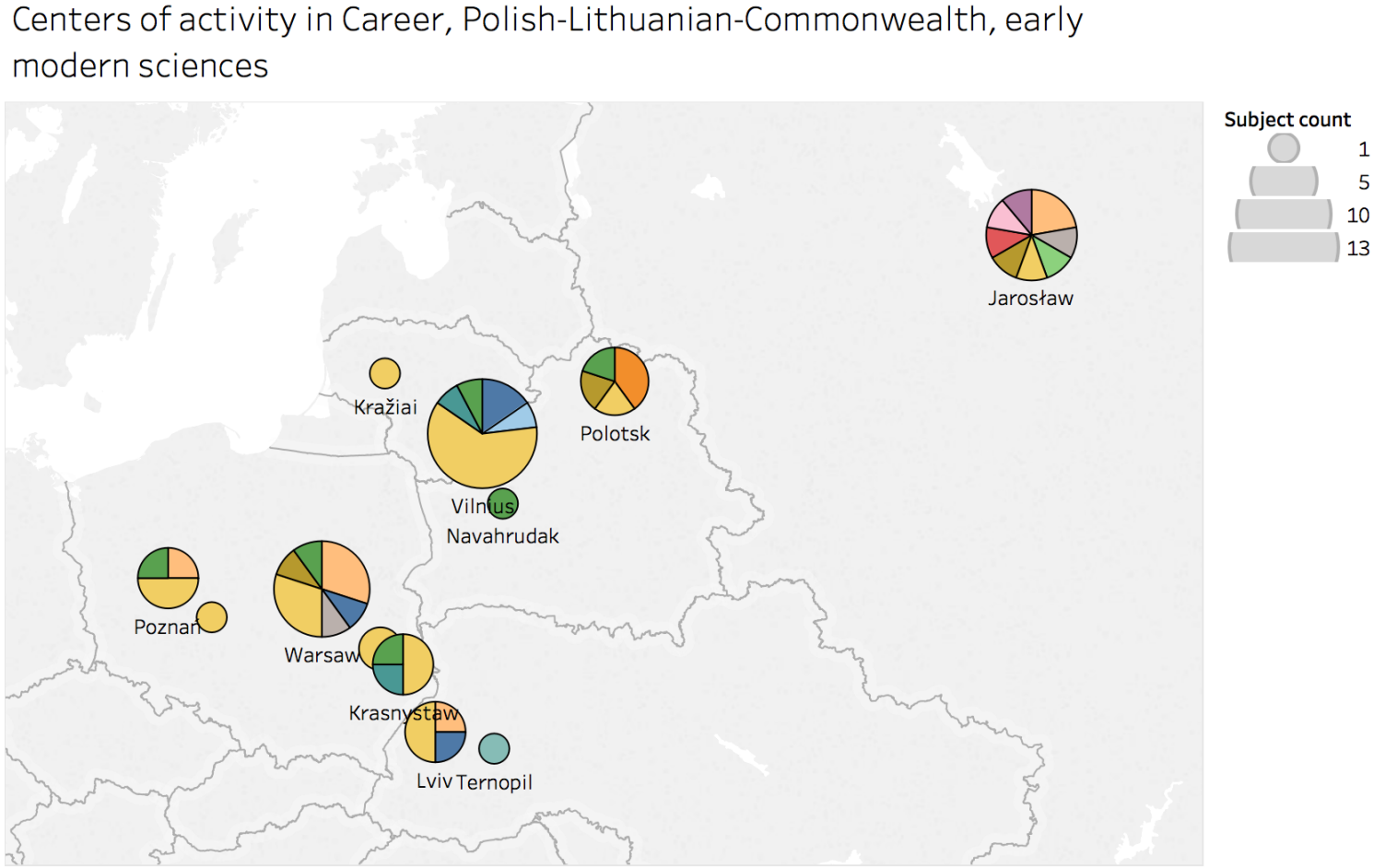


(b) Career

Figure 4.9.: Jesuit centers of activity, overall map. Subjects from the early modern sciences marked in green.


Centers of activity in Education, Polish-Lithuanian Commonwealth, early modern sciences
Subject count
1
2
4
6
8
Vilnius
Warsaw
Krasnystaw
Lviv
Kalisz
Poznań

(a) Education



(b) Career

Figure 4.10.: Spatial distribution of subjects from the early modern sciences in the Polish-Lithuanian Commonwealth.

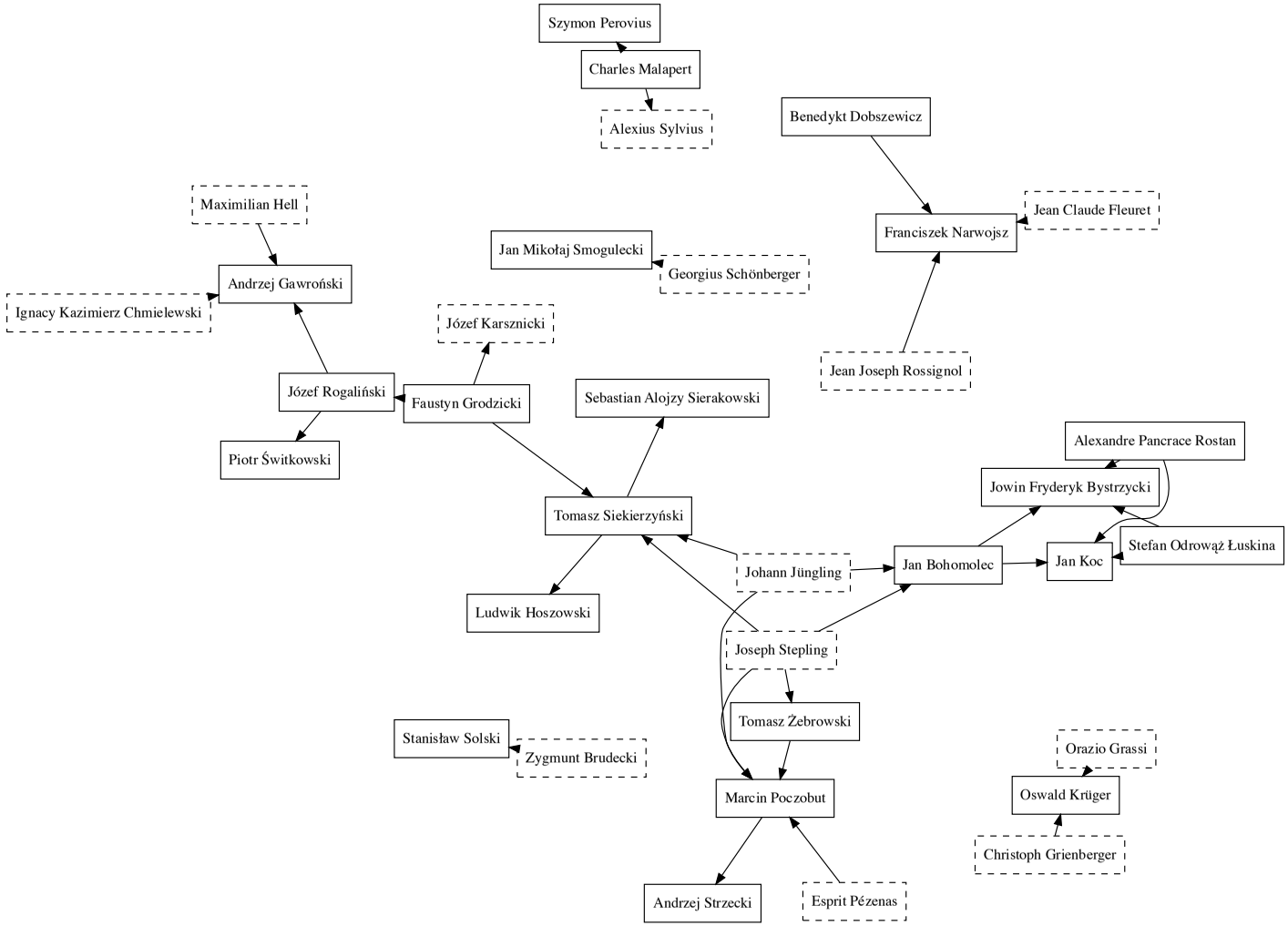


Figure 4.11.: Teacher-student relationships based on the Jesuits from the Polish-Lithuanian Commonwealth. Arrows indicate the direction of instruction.

Chapter 5.

Follow-up work

In the previous two chapters, I have introduced the practical implementation of the Jesuit Science Network and presented its current state. In Chapter 3, I set the focus on the workings behind and within the user-accessible project website jesuitscience.net, while I used the case study in Chapter 4 as an example for query-based evaluations of the underlying database. In the following, I would now like to turn my attention from the currently existing to the prospectively possible, and risk a look into the future. In the course of devising and building the JSN, starting points for improvement, further processing of the collected data, or cooperation with other research projects have appeared on all levels, be they with regards to the concept, the digital infrastructure, or content. Subsequently, I would like to present some of the ideas that have come up and thus show the great potential that this project holds in the near future.

5.1. Long-term operation and archiving

A discussion of follow-up projects to the Jesuit Science Network, however, first requires some clarifying on its long-term operation and archiving. After all, the technical operationality of the database and website as well as its online accessibility have to be ensured before any actual research can be done. As with many aspects of digital work, standard procedures are often still in their infancy. Contributions to the discussion on long-term preservation have been made from the points of view of different fields, ranging from efforts to make current technologies future-proof to re-igniting the debate on what is actually worth saving.[1]

1. See, for example, the anthologies Paul Klimpel and Jürgen Kneiper, eds., *Was bleibt? Nachhaltigkeit der Kultur in der digitalen Welt* (i.Rights Media, 2013), and "Digital Amnesia", IG Rote Fabrik, December 2016, accessed 09/26/2017.

Bearing this in mind, I would like to just briefly touch upon three particular issues that I am facing with the JSN. They are, at the same time, also quite exemplary for many other, especially smaller projects in the Digital Humanities.

The first and biggest challenge is posed by the fact that the Person Data Repository project is now defunct, depriving the JSN from further development and official support with regards to its digital infrastructure. While it is possible to bypass the PDR repository via the SQL database that supplies the project website, and insert any changes or new data directly into it, this should only be considered as a last resort. Such an approach is neither good practice nor was it ever intended nor could it possibly replace the functionalities of the PDR. The traditional model of restricted runtimes and limited funding periods for research projects ceases to function when it comes to software development and digital infrastructures. As soon as clients appear, outside researchers who adopt the infrastructure for their own work, the end of development on the technical side often entails the unwanted end of research on the client side, as well.

The second issue concerns the very practical long-term accessibility and archiving of the collected data and the project website, in other words, the long-term allocation of sufficient, secure, and stable server space. At first glance, the simplest solution to this seems to be using server space provided by an academic institution; however, this comes with a couple downsides. To begin with, the allocation of server space with academic institutions is very often tied to having an employment at said institution, so that moving positions usually also requires moving the entire project—which is not only not a good idea because of the old adage to never touch a running system, and the main reason why the Jesuit Science Network was set up independently at own cost. Moreover, paid services can be chosen at will and after careful consideration of what is best and most suited for the project, with the added bonus that they are usually taken care of quicker in the case of downtime. On the other hand, while server space is not necessarily expensive, it warrants regular payments.

The third and final issue that I would like to address has to do with the long-term technical support needed in order to maintain and update the project website. The professional design of jesuitscience.net is not only concerned with its looks, but also its functionalities, and as such possesses a complexity that requires care beyond the completion of this thesis. This care, however, cannot be demanded as a continued, unpaid favor from developer Lars Feyerabend. Choosing a simpler, less sophisticated design, on the other hand, would distinctly limit what the JSN can do, and hence cannot be the purpose of this work. As a result, the question of long-term technical support remains unsolved for the time being.

5.2. Linking the JSN with the Early Modern Letters Online database

The first idea for follow-up work aims at connecting the JSN with the Early Modern Letters Online database, for short EMLO.[2] EMLO is an online catalog of letters from the sixteenth to the eighteenth centuries compiled in an ongoing collaborative effort to make an inventory of the Republic of Letters.[3] It offers the user to search in the overall categories of 'People', 'Dates', 'Places', 'Content', 'Repositories and Editions', and 'Catalogues', while allowing further refinement, for example after the 'Recipient', 'People Mentioned', 'Postage Marks', or 'Paper Types'.[4] It is also possible to freely browse all entries.

Members of the Society of Jesus were naturally active participants in the Republic of Letters.[5] Particularly for those active in the early modern sciences, written correspondence with other scholars within and outside of the Society was not just an obligation to fulfill their duties, but a welcome and needed medium for the exchange of ideas and information. The Polish Jesuit Adam Adamandy Kochański (1631–1700), for instance, kept scholarly communication with the German orientalist Andreas Müller (1630–1694), the Polish King John III. Sobieski (1629–1696, reign 1674–1696) who had appointed him as a royal mathematician in 1691, and the German Jesuit Gaspar Schott (1608–1666), just to name a few.[6] Schott had briefly met Kochański in Würzburg and asked the Pole to make the drawings for his *Magia universalis naturae et artis*;[7] upon working on the book,

2. See `http://emlo.bodleian.ox.ac.uk/`, accessed 22/09/2017.

3. "The republic of letters emerged in the seventeenth century as a self-proclaimed community of scholars and literary figures that stretched across national boundaries but respected differences in language and culture. Its members were linked to one another by their commitment to the advancement of knowledge and, in the eighteenth century, to the progress of humanity achieved through the exchange of information and criqtiques." Susan Dalton, *Engendering the Republic of Letters : Reconnecting Public anc Private Spheres in Eighteenth-Century Europe* (Montreal: McGill-Queen's University Press, 2003), p. 7. A select bibliography on the Republic of Letters can be found on `http://www.culturesofknowledge.org/?page_id=191`, accessed 21/08/2017.

4. See `http://emlo.bodleian.ox.ac.uk/advanced`. Accessed 10/10/2016.

5. From early on, members of the Society were exhorted to keep in touch with each other and with their superiors by sending letters, many of which have been edited in the *Monumenta Historica Societatis Iesu*. O'Malley, *The First Jesuits*, p. 2; there were even specific rules for the "when, why, and to whom", see Grant Boswell, "Letter Writing among the Jesuits: Antonio Possevino's Advice in the 'Bibliotheca Selecta' (1593)", *Huntington Library Quarterly* 66, nos. 3/4 (2003): pp. 255–258.

6. A sizeable portion of Kochański's letters were edited in 2005. They offer a fascinating insight not only into the works and routines of a Jesuit scholar in the early modern sciences, but also into the person Kochański himself. Bogdan Lisiak and Ludwik Grzebień, eds., *Korespondencja Adama Adamandego Kochańskiego SJ (1657–1699)* (Kraków: Wyższa Szkoła Filozoficzno-Pedagogiczna Ignatianum, 2005).

7. Zofia Pawlikowska-Brożek, "Adam Adamandy Kochański i jego prace na tle nauki XVII. w.", *Studia i materiały z dziejów nauki polskiej* 19 (1974): p. 5.

Kochański kept sending Schott not only his remarks and corrections, but also own new theories and constructions based on what he had read in the *Magia*. Schott, in turn, took these written deliberations and added them as an independent chapter in his *Cursus Mathematicus*.[8]

While both Kochański and Schott can be found in EMLO,[9] the particular letters alluded to above are not (yet) recorded there. Nevertheless, they illustrate perfectly how the Jesuit Science Network and Early Modern Letters Online can complement each other's contents and goals. Drawing on my experiences with the sources for the JSN, Jesuit biographies tend to rather focus on motivations and circumstances than on written correspondence, if they do so at all, so that this kind of relationship is also not well represented in my collected data. EMLO, on the other hand, might have records of exactly these letters, while lacking any further information on the senders, recipients, or situations. By linking to each other, EMLO gains biographic and contextual information from the JSN that it itself cannot provide to this degree, and the JSN can extend its offer to further material about the Jesuits treated.

With the advantages obvious for both sides and the intention to cooperate mutually affirmed, the only remaining problem is the actual technical implementation of such a linking. The use of appropriate BEACON files as introduced on page 133 currently seems like the best way to go, but requires further investigation and time.

5.3. Historical network analysis

The SQL database that is employed in the Jesuit Science Network website and that imports its contents from the XML PDR repository can be used as starting point for further data processing. In fact, its structure and query language are exceptionally well suited for this task, and the results of any query can be stored in a variety of file formats. For that purpose, CSV (comma-separated values) is the format of choice. CSV stores tabular data in plain text and can easily be handled with text editors, all popular spreadsheet software, and many other applications. In Section 4.2, the section

8. Adamus Adamandus Kochánnski, *Analecta Mathematica, sive Theoreses Mechanicae Novae. De natura quinque fundamentalium; et de novo motionum machinalium Principio Universali et unico; nec non de Motus artificialis perpetui possibilitate*, in *Cursus mathematicus sive absoluta omnium mathematicarum disciplinarum encyclopaedia*, by Gaspar Schott (Herbipoli; Francofurti: Schönwetter; Herbipoli: Hertz, 1661), pp. 621–657.

9. Kochański's letters are listed under `http://tinyurl.com/pxlrhe8`, Schott's under `http://tinyurl.com/cppblp4` (the short URLs are provided directly by EMLO). The correspondence of the latter is furthermore gathered in a particular catalog, `http://emlo.bodleian.ox.ac.uk/blog/?catalogue=caspar-schott`, offering broader information on Schott, his correspondence partners, and the letters themselves. All links accessed 22/09/2017.

showcasing the Jesuit Science Network, I provided more examples of visualizations and evaluations on the basis of SQL queries.

In particular, CSV is a format that can be fed to many network analysis tools, opening the door to a still very new field of activity for historians: historical network analysis. While social network analysis has been developed and established for decades, historical network analysis is still in the process of claiming and defending its own footing, with regard to both sociologists and particularly historians. Still, a growing amount of mostly introductory literature has been published on this topic in recent years. The Österreichische Zeitschrift für Geschichtswissenschaften, for example, issued a special edition on historical network analysis in 2012,[10] launching into the topic with a paper by Claire Lemercier introducing the basic why and how.[11] Further introductions and examples can be found in a 2015 anthology edited by Markus Gamper et al. that is directed at historians and political scientists,[12] as well as a 2013 paper by Marten Düring et al. that in addition offers a survey of the so far existing literature.[13] In 2016, Marten Düring et al. published the first handbook on historical network analysis.[14] I would also like to refer to Marten Düring's dissertation containing a thorough methodological account,[15] and a 2017 paper by Matteo Valleriani who details his use of historical network analysis in the study of early modern commentaries on Sacrobosco's Sphere.[16] Finally, Marten Düring runs a website and a Twitter account dedicated to historical network research, maintaining a "platform for scholars to present their work, enable collaboration and provide those new to network analysis with some helpful first information".[17] The

10. Albert Müller and Wolfgang Neurath, eds., *Österreichische Zeitschrift für Geschichtswissenschaften : Sonderheft Historische Netzwerkanalysen* 23, no. 1 (2012).

11. Claire Lemercier, "Formale Methoden der Netzwerkanalyse in den Geschichtswissenschaften: Warum und Wie?", *Österreichische Zeitschrift für Geschichtswissenschaften : Sonderheft Historische Netzwerkanalysen* 23, no. 1 (2012): pp. 16–41.

12. Markus Gamper, Linda Reschke, and Marten Düring, eds., *Knoten und Kanten III : Soziale Netzwerkanalyse in Geschichts- und Politikforschung* (Bielefeld: transcript Verlag, 2015).

13. Marten Düring and Linda von Keyserlingk, "Netzwerkanalyse in den Geschichtswissenschaften. Historische Netzwerkanalyse als Methode für die Erforschung von historischen Prozessen", in *Prozesse : Formen, Dynamiken, Erklärungen*, ed. Rainer Schützeichel and Stefan Jordan (Wiesbaden: Springer, 2015), pp. 337–350.

14. Marten Düring et al., eds., *Handbuch Historische Netzwerkforschung* (Berlin: LIT, 2016).

15. Marten Düring, *Verdeckte soziale Netzwerke im Nationalsozialismus : Die Entstehung und Arbeitsweise von Berliner Hilfsnetzwerken für verfolgte Juden* (Berlin: De Gruyter Oldenbourg, 2015).

16. Matteo Valleriani, "The Tracts on the *Sphere*: Knowledge Restructured Over a Network", in *The Structures of Practical Knowledge*, ed. Matteo Valleriani (Springer, 2017), pp. 421–473. Valleriani also co-authored a more theoretical paper on networks from the point of view of the history of knowlege with Jürgen Renn et al., "Netzwerke als Wissensspeicher", in *Die Zukunft der Wissensspeicher : Forschen, Sammeln und Vermitteln im 21. Jahrhundert*, ed. Jürgen Mittelstraß and Ulrich Rüdiger (Konstanz: UVK, 2016), pp. 35–79.

17. See `http://historicalnetworkresearch.org/` and `https://twitter.com/hnr_org`, both ac-

website in particular offers an extensive bibliography.[18]

The Jesuit Science Network now not only refers to networks by its name, but indeed contains a plethora of information that can be evaluated accordingly. The network visualizations in Figures 4.4, 4.11 and 5.1b on pages 174, 185 and 197, for example, deal with relations between places of birth and places of entry as well as teacher-student connections between Jesuits, all of which can be the focus of a more intricate investigation. The other figures shown in the previous Section 4.2 also provide possible starting points into a data-driven evaluation. While the extent of such a study, especially with regards to the necessary knowledge, goes beyond the scope of this thesis, a historical network analysis based on the JSN could certainly be one of the first follow-up projects.

5.4. Exhaustion and comparability of data sources

As I have stated multiple times, the *Bibliothèque de la Compagnie de Jésus* constitutes one of the main sources, if not the main source of information for the Jesuit Science Network. Data entry from the *Bibliothèque* relies on a bibliographically categorized list provided in its tenth volume; however, this list disregards all those Jesuits who, while active in the early modern sciences in one way or another, are not known to have published anything.[19] As such, there is a gray number of valid entries missing in the current version of the JSN.

This problem can fortunately be remedied relatively easily on the condition that a high-quality OCRed version of the *Bibliothèque* becomes available in plain text. In that case, a search algorithm can be drawn up to scour the text files of the bibliographical volumes, capturing any entries that match a predefined set of catchphrases indicating an entry of interest for the JSN. The thus collected names would then be checked against the current data stock and, if not found to be a match, marked for future entry. This, too, could be automated.

Determining the set of catchphrases to look for, along with setting up the search algorithm, would involve most of the conceptional effort for this task. Performing the search itself and checking against existing entries, in turn, would be rather straightforward; the entry of the newly found data would eventually have to be performed by hand, a diligent but routine piece of work. Beyond my control, however, but also absolutely vital for the execution of this idea, is the availability of a high-quality OCRed edition

cessed 08/15/2017. The quote is from the About page.

18. See `http://historicalnetworkresearch.org/resources/bibliography/`, accessed 08/15/2017.

19. Refer to the discussion in Section 3.5.

of Sommervogel. At the time of writing, the textual recognition, search functionalities, and overall quality of any freely accessible scans of the *Bibliothèque* do not meet the requirements formulated above.[20]

A second possibility to exhaust available sources would be to include still existing student and teacher catalogs kept by early modern Jesuit colleges. While this approach can be expected to provide many additional names and details, it requires a bigger orchestrated effort; most of these catalogs are kept in archives and hence require direct and local access by someone willing to spend a lot of time reading, researching, and finally inputting the retrieved data directly on their end. The first two major issues with this idea, of course, concern finding local collaborators as well as achieving a consistent quality of data entry among a diverse group of people, and are preceded by the already addressed problem of long-term operation and especially the discontinuation of the Person Data Repository. While desirable in theory, an extension of the Jesuit Science Network by college catalogs is hence most unlikely to be achieved.

In contrast to the Society of Jesus' own records, modern compilations with a focus on a particular region or college are much easier to incorporate in the JSN. Provided that they are easily accessible—which includes their language—and that their information structure is similar enough to the one of the Jesuit Science Network, exhausting them as sources is simply a task of finding them and inputting the data. At present, this has already been done with Georg Schuppener's work on Jesuit mathematicians at the Prague college and especially Bogdan Lisiak's selection of Jesuits active in the early modern sciences in the Polish-Lithuanian Commonwealth, a group whom I used as a sample for my showcase of the JSN in the previous chapter.[21]

Finally, exhausting the sources especially involves recording all available references for a particular piece of information; so far, I have only noted one reference per aspect and prioritized more modern sources to the *Bibliothèque*.[22] Completing the reference entry accordingly would allow for quantitative comparisons between sources in general and against the Sommervogel series as the main and basic source in particular, for instance

20. Such a version is hosted on the Internet Archive, with the sources and scans provided by the Boston College Library. The contents of any volume can be searched through a very simple search interface that has no advanced mode and tends to not find page numbers correctly. The Internet Archive also offers plain text versions for download; however, these suffer from issues such as incorrect encoding and are hence mostly unusable. The university library at Göttingen University has recently concluded a new PDF scan of Sommervogel, but provides no OCR.

21. Another example for a regionally focused study that provides biographical information is Ugo Baldini, "The teaching of Mathematics in the Jesuit Colleges of Portugal, from 1640 to Pombal", in *The Practice of Mathematics in Portugal*, ed. Luís Saraiva and Henrique Leitão (Coimbra: Universidade de Coimbra, 2004), pp. 293–465.

22. See page 106.

what types of information are commonly shared, what kinds are rarely given, and how extensive the *Bibliothèque* actually is. It could also possibly help with determining which differing information is most probably correct or incorrect and recognizing typographical mistakes during entry.

5.5. Prosopographical infrastructure of religious orders

The last possible follow-up that I would like to present here is also the most ambitious. From the standpoint of the Jesuit Science Network, its goal is not just to grow by itself, but to establish connections to other projects, like the earlier discussed EMLO, and possibly be embedded within a larger framework. The Austrian-based proposal with the current working title PIRO could be a perfect match for that. Conceived by Thomas Wallnig, Vienna University, and Georg Vogeler, Graz University, PIRO aims to establish a common digital prosopographical infrastructure of religious orders (hence the initialism PIRO) that can bring together researchers working on this topic set in the early modern period and possibly beyond. Aside from the aim to provide a common methodological ground and usable tools, which could well lead to establishing a set of standards for the prosopographical study of religious societies, PIRO's realization would allow for wide-scale cooperation and comparative research.

At the moment, the project is still in very early development and thus dealing with the same questions that I had to answer for the Jesuit Science Network in Sections 3.2 to 3.4: What kind of sources are there; what kind of information should be collected; and most of all, what kind of digital infrastructure should/can be chosen? As PIRO is supposed to cater to international research groups all dealing with their own 'flavor' of religious order, sources, technical expertise, and interest, these fundamental issues will be tackled in a collective effort, and the first workshop in that regard already took place in Vienna in February 2017. Fortunately, not everything has to be built from scratch, and PIRO can benefit from prior experiences.

One advanced contributor to the project can be found in the research group around the "Bio-Bibliographical Database of Members of Religious Orders Living in the Czech Lands in the Early Modern Age", led by Kateřina Bobková-Valentová and located at the Institute of History at the Czech Academy of Sciences.[23] The biographical database collects information from primary sources—the largest difference in comparison with the

23. The project website is unfortunately only available in Czech, but the catalog itself comes with an English version. See `http://www.hiu.cas.cz/cs/databaze/bio-bibliograficka-databaze.ep/` and `http://reholnici.hiu.cas.cz/katalog/eng/baze.htm`, respectively, both accessed 15/08/2017.

Jesuit Science Network—and, among others, treats members of the Capuchins, Brothers of Mercy, Piarists, Premonstratensians, and also Jesuits.[24]

Thomas Wallnig and Georg Vogeler themselves laid the foundations from which PIRO arose with their collaboration, as part of a larger group, on ProDomo, a recently published online database storing several hundred records on four Austrian monasteries and their eighteenth-century inhabitants.[25] ProDomo was co-sponsored by the involved monasteries who allowed the researchers to access their records for data collection, hence giving it the status of a pilot experiment that could also be adopted by other monasteries in the same or a similar form. Interestingly enough, ProDomo uses the Person Data Repository as its digital infrastructure, although it remains much more closely to the predetermined structures and also does not employ any additional type of database for its online publication. As such, the project website allows a more direct look into the project's inner workings than the JSN.

The necessary expertise concerning the historical contents of ProDomo is provided by learned representatives of the religious communities themselves, such as P. Alkuin Schachenmayr OCist, as well as by the research group around Thomas Wallnig, who himself has a specialization in Benedictine history during the early modern period. At that time, more specifically in 1754, the Benedictine historians Oliver Legipont (1698–1758) and Magnoald Ziegelbauer (1689–1750) edited the *Historia rei literariae Ordinis S. Benedicti*,[26] a sort of scholarly history of the Benedictine order. It is, in parts, quite similar to what Carlos Sommervogel later did for the Society of Jesus, and so it goes without saying that an analysis of data based on the two works has to be done, even if the *Bibliothèque* is 150 years younger.[27]

Consequently, Thomas and I have put together samples in order to trial run such a study. The Benedictine sample was assembled from the third chapter of the fourth volume of the *Historia rei literariae*, entitled *Scriptores de medicina, philosophia et mathematica*; out of Caput 3/2 on philosophy, only the physicists were studied, Caput 3/5 on

24. The degree of details varies highly between the particular orders. Not further surprising considering the Jesuit habit of keeping meticulous records, the most extensive entries can be found for Jesuits.

25. See `http://prodomo.icar-us.eu/`, accessed 15/08/2017.

26. Oliverius Legipontius and Magnoaldus Ziegelbauer, *Historia rei literariae Ordinis S. Benedicti* (Augustæ Vind. [etc.] : Sumptibus Martini Veith, 1754).

27. It should be noted that the *Historia* was explicitly compiled with the goal to differentiate the Benedictines against the Jesuits and prove the Benedictines' own activity in all the subjects, at all the places, during all the time. More on the authors, particularly Legipont, can be found in Michael Grünwald, "Forschen – P. Oliver Legipont (1698–1758) aus Groß St. Martin und seine Beziehungen zur Abtei Göttweig", in *Benediktinisches Leben in Köln*, ed. Marcel Albert (Siegburg: Verlag Franz Schmitt, 2010), pp. 119–143. I would like to thank Thomas Wallnig for providing me with this reference along with all the other insight on the Benedictine order that I am recounting here.

musicians was dropped entirely, and instead, Caput 6/12 on inventors was added. The information for the Jesuit sample was taken from the Jesuit Science Network database. The further parameters for both were activity in the early modern sciences after 1550 (to allow for the first established colleges in the Society of Jesus) and a birth date before 1700 (a deliberate cutoff).[28] We hence arrived at a sample size of 71 Benedictines and 218 Jesuits.[29]

I then prepared the two sets for further processing with the data visualization software Tableau and created Figure 5.1 on page 197, a map plotting the places of birth versus the places of entry in the respective orders.

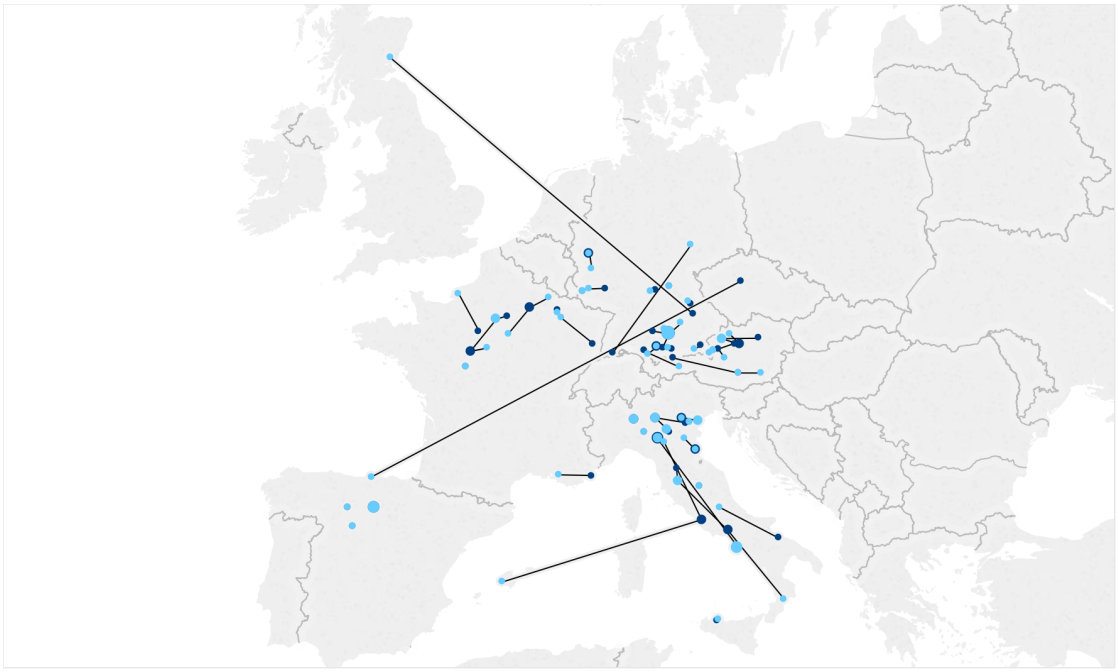
Taken just by themselves, these images do not reveal any new truths, but illustrate and confirm impressions and statements from the literature in a visual and thus more directly accessible way. Figure 5.1b demonstrates that the Jesuits came from all over Europe, had various centers and bigger 'points of entry' into their Order, and were, indeed, as mobile as their fourth vow required. Figure 5.1a similarly gives a graphical representation of the Benedictine locality and sedentariness. The former is particularly brought about by the fact that Benedictine recruitment areas were quite confined geographically, meaning that a prospective member born in France was to enter the order in France, as well; in turn, this resulted in the 'national' congregations keeping mostly to themselves.

Still, the images are valuable tools to better grasp these fundamental properties of the respective orders, made possible only by the application of computational methods. It is when they are examined together that they really show their true potential for a comparative study, in this case demonstrating the supremacy of the Jesuits over the Benedictines concerning the amount of members active in the early modern sciences. This could be further finetuned to a focus on particular periods or subjects, for example, or any other kind of information that the underlying sources commonly give.

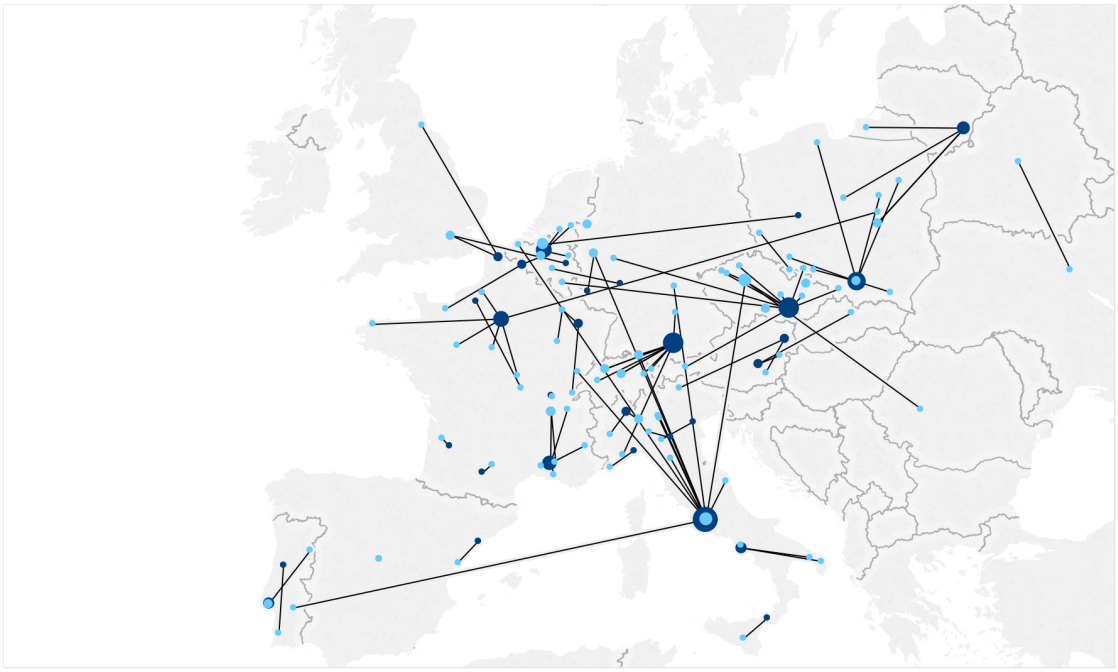
The choice of samples for Figure 5.1 is certainly susceptible to debate in terms of proper methodology, but this little study just aims to test the waters and give a first insight into the possibilities behind collaborative work on the scale that PIRO proposes. Of course, anything involving data from the Jesuit Science Network has its focus on the early modern sciences, but without this particular specialization, data collected and

28. To be precise, in this context I understand a Jesuit to have been active in the early modern sciences after 1550 if all of his aspects in the Career category that contain subjects from the early modern sciences have a date later than 1550. In order to be able to visualize the results, the aspects concerning birth and entry are furthermore required to have a place information.

29. The very low appearing number of Benedictines can possibly be explained by the different internal positioning; in comparison, the Society of Jesus placed more value on the early modern sciences. The gap would certainly be much smaller in other areas such as history or theology. In addition, the Benedictines were much less involved with teaching chairs.



(a) Benedictines



(b) Jesuits

Figure 5.1.: Places of birth (light blue dots) versus places of entry (dark blue dots) for select members of the Benedictine and Jesuit orders. Dot size scaled with the amount of people who were born and entered at this place, respectively. Benedictine data courtesy of Thomas Wallnig, visualization generated with Tableau, map copyright OpenStreetMap contributors (see `http://www.openstreetmap.org/copyright`).

shared on PIRO can be evaluated in terms of any other aspect of religious life in the early modern period. While it is possible to already do such work based on existing projects such as the JSN, ProDomo, and the Czech database, a common infrastructure would immensely simplify or only just facilitate collaborative and comparative research by way of providing common technical practicalities. In addition, it would allow for greater visibility of the participating researchers and help develop digital infrastructures.

Connecting the Jesuit Science Network with or even integrating it within PIRO then poses another challenge, one that could potentially require some very fundamental changes to the internal structure. However, with both the XML and the SQL databases in use along with all their advantages that I have already touched upon, the outlook for a cooperation on the scale of PIRO is both positive and realistic.

5.6. Completing the Jesuit Science Network?

When I take stock of the Digital Humanities literature that I used for this thesis, it seems to me that the focus lies mostly on methodology and the discussion of potential. But rarely, or rather, not at all, does it address the question of what it means to be done with a digital project—with the notable exception of a cluster of four articles published in 2009 in the Digital Humanities Quarterly journal.[30] Before indeed finishing the main part of my thesis and proceeding to the closing remarks, I would hence like to discuss the main points of these papers and reflect upon their meaning and impact for my own work on the Jesuit Science Network.

To begin, Susan Brown at al. point out that "[w]orking at the interface between humanities research questions and evolving digital methods means that projections about the trajectories of digital humanities work are less likely to be accurate than those of traditional scholarship",[31] or in other words, that it is difficult to accurately predict the further fate of the Jesuit Science Network, including the actual feasibility of approaching and successfully implementing any of the ideas suggested in this chapter. What is more, digital publications—this especially entails jesuitscience.net—struggle with their

30. Brown et al., "Published Yet Never Done: The Tension Between Projection and Completion in Digital Humanities Research"; Matthew G. Kirschenbaum, "Done: Finishing Projects in the Digital Humanities", *DHQ: Digital Humanities Quarterly* 3, no. 2 (2009); William A. Kretzschmar, Jr., "Large-Scale Humanities Computing Projects: Snakes Eating Tails, or Every End is a New Beginning?", *DHQ: Digital Humanities Quarterly* (2009); David Sewell, "It's For Sale, So It Must Be Finished: Digital Projects in the Scholarly Publishing World", *DHQ: Digital Humanities Quarterly* 3, no. 2 (2009).

31. Brown et al., "Published Yet Never Done: The Tension Between Projection and Completion in Digital Humanities Research", paragraph 6.

"doneness"[32] in several ways. Not only does the medium Internet not have any of the restrictions stipulated by the medium print (for example, in terms of extent, forms of rendition, or editability), it also prevents "doneness" through continuous technological advances to which digital projects have to adapt in order to stay relevant. The necessity to ensure a long-term operation and accessibility of project results and the inherent variability of digital information furthermore make it difficult to just 'be done'.[33]

Matthew Kirschenbaum similarly calls attention to the ever changing nature of the Internet by bringing up the question after the "measure of 'completeness' in a medium where the prevailing wisdom is to celebrate the incomplete, the open-ended, and the extensible".[34] He also bemoans the lack of incentives to finish projects in the US as beginning something new is much more profitable than bringing something existing to an end, especially in terms of financial support and job security. Judging by the plethora of stipends and funding programs for novel DH projects within the German research landscape, this also holds for the domestic context.

William Kretzschmar, Jr., first approaches the topic from a linguistic point of view, clarifying that 'to finish' something can mean to make or perform it completely, or to perfect it in detail.[35] A digital research project can hence be understood as the sum of "particular tasks or experiments, each of which is capable of being 'finished' in both senses of the word";[36] in project management, these tasks or experiments are also called deliverables, as they represent independent components that provide a particular functionality and get delivered to the client after completion. The filters on the results page of a search within the Jesuit Science Network, for example, are such deliverables.

Similar to Brown et al., Kretzschmar also details the necessity to react to technological advances in order to stay relevant and usable, which of course prevents ever finishing a project in either sense of the word.[37] Following this necessity, he talks of continuous revisions for the research project he himself is associated with, the Linguistic Atlas Project, and while the corresponding website is still online, the last update in the News section dates back to December 2011.[38] Since the Linguistic Atlas dates back to 1990 and hence had to adapt to many new developments in computer science over the course of the 90s, I would consider this an impressive runtime, especially with the data still

32. The term is used multiple times in ibid.
33. Ibid., paragraphs 17–21.
34. Kirschenbaum, "Done: Finishing Projects in the Digital Humanities", paragraph 2.
35. Kretzschmar, Jr., "Large-Scale Humanities Computing Projects: Snakes Eating Tails, or Every End is a New Beginning?", paragraph 1.
36. Ibid., paragraph 2.
37. Ibid., paragraphs 8–11.
38. See `http://www.lap.uga.edu/Site/News.html`, accessed 09/25/2017.

available via an online graphical user interface.[39]

The final paper in this cluster, contributed by David Sewell, proposes several intrinsic and extrinsic criteria to determine the 'doneness' of digital scholarship. The intrinsic criteria depend on two main properties that projects might or might not have, namely definable boundaries for their extent and goals as well as the satisfaction of said goals.[40] While I want to save the discussion about whether the Jesuit Science Network has achieved its goals for the final remarks in Chapter 6, I can already say that the variety and diversity of the projected follow-up ideas shows that there are no real boundaries to the JSN and what it can do. As such, this intrinsic criterion prevents it from being finished.

As for the extrinsic criteria listed by Sewell, most of them have already been named: economic constraints, i. e., lack of continued funding, technological changes, aggregation and standards evolution;[41] at least I do not have to worry about competition as far as I am aware. But there is one more extrinsic criterion particular to PhD projects, and that is the necessity to submit the project package at some point in time in order to complete the doctoral procedure itself. This might be quite the overlooked constraint as it applies only to a specific group of researchers in a specific situation, but speaking as a member of this group, I would deem it one of the most 'motivating'.

And what is more—submitting the thesis does not mean that the project is finished.

39. See `http://www.lap.uga.edu/Site/LICHEN.html`, accessed 09/25/2017. The GUI itself appears to be quite recent, but no specific dates are given anywhere.

40. Sewell, "It's For Sale, So It Must Be Finished: Digital Projects in the Scholarly Publishing World", paragraphs 33–38.

41. Collaborations with other projects in particular will pose new or modified requirements towards the structuring and processing of data in the Jesuit Science Network.

Chapter 6.

Final remarks

In keeping with the sentiment of Section 5.6 that completion is not as clear-cut for digital scholarship as it is in a traditional context, I prefer to conceive this last chapter not as a conclusion to the Jesuit Science Network as a project, but rather as a collection of final remarks concerning the accomplished work. In the following, I hence want to reiterate the essential experiences and observations described over the course of Chapters 2 to 5 in order to present a nuanced picture of my work. In doing so, I want to outline the achievements, opportunities, and challenges, but also issues of digital history as they have presented themselves to me.

The entirety of my work for my PhD project hinges on the fundamental interest in the *who*, *what*, *where*, and *when* of Jesuit activity in the early modern sciences. First, it determines the main goal of the Jesuit Science Network: provide a tool that allows to find answers to these four questions based on a collection of data as comprehensive as possible.[1]

As I have derived in Section 3.1, this goal can be translated into a practical research task revolving around the creation of a biographical database that

1. caters to a data model as general as possible and as particular as necessary,
2. allows for complex searchability of the information contained,
3. and is accessible via a corresponding project website.[2]

In Section 3.4, I have shown that the data model of the Person Data Repository, my digital infrastructure of choice, comfortably covers all of the biographical information

1. Judging by a count of 1042 scholars in the database, 998 of them Jesuits—both numbers concern the latest version from 09/20/2017—and in light of the discussion of Steven Harris' higher number of 1600 Jesuits in Section 3.6, one could argue I have achieved the goal of comprehensiveness.
2. This list was initially presented on page 82.

developed in Section 3.3 (especially Table 3.2 on page 94), and that it can easily be adjusted to particularities of Jesuit biography such as the date of entry into the order.

Concerning the complex searchability, I have shown in Section 4.2 that access to the SQL database allows for complex coherences to be expressed and the corresponding data to be extracted and analyzed, mirroring the historical context and offering stimuli for further investigation.

As for the online accessibility of the Jesuit Science Network, I have not only shown that the JSN is accessible on the Internet in the basic sense of the word, but also that by considering aspects such as user interface design or SEO, digital projects can be made more accessible even to a broader audience. The highly filterable search at the core of the JSN, as demonstrated by the results page in Figure 3.13 on Page 129, illustrates that the vast body of data can easily be searched and explored even by non-technical-minded researchers.

This shows that the fundamental historical research interest is, indeed, ingrained in all aspects of the technical implementation. The ultimate evaluation, however, is at the discretion of the users; they have to decide whether the JSN proves successful as a research and information tool and adds value to their own work.

But there also have been hurdles along the way. The lack of continued funding and the eventual ending of the PDR project was of particular consequence for the JSN. No funding means no further support for and development of the project infrastructure, and the question arises as to how long the Berlin-Brandenburg Academy for the Sciences and Humanities, the PDR's parent institution, will keep the PDR data repositories running. This uncertainty naturally makes it difficult to implement a reliable long-term operation, by now a justified demand regularly brought forward towards digital scholarship.

Simultaneously, this renders one particular aspect of the overall inadequacy of institutional support for digital historical scholarship visible, namely wanting long-term schemes to keep infrastructures up and running. Guidelines for methodology and software are lacking, as well, as are established standards and best practices. This quite likely contributed to some of the hiccups described in Chapter 3, for instance, my decision to only include one reference for pieces of information that are reported by multiple sources, as I had no opportunities for comparison.

In this regard, digital work in the humanities struggles with three bottlenecks in particular. The first one concerns the overall scarcity of both time and funding, not only restricting what can be done, but also determining the detail of execution. It is moreover a contributing factor for the second bottleneck, limited access to experts such as professional developers or designers. A third bottleneck, finally, can be caused by

poor availability of digitalized source material. The exhaustion of the *Bibliothèque de la Compagnie de Jésus* in the Jesuit Science Network, for example, cannot be carried out without a properly OCRed digitalization which currently does not exist.

Most critical, however, is the lack of a legal framework. This especially affects contemporary modes of publication of digital research and research data, and leads to a situation in which digital scholarship, while adhering to the same rules of scholarly conduct as its traditional root, is not guided by the same laws.

Whereas the clarification of legal questions is ultimately a matter of national governments, practical issues such as the continued operation of project websites can, within reason, be mitigated on the level of the research projects themselves, e.g., by budgeting for the necessary expenses from the very beginning. I furthermore hope to have shown with my account on the Jesuit Science Network that a professional conception and design are immensely vital for the success of a project, with success defined in the form of a deliverable end product that is technically stable, comfortable to use, and, frankly, provides the user with an experience that makes them want to come back. The intermediary SQL database used by the JSN, for example, plays an important role in this. It not only facilitates the data access on jesuitscience.net modeled according to the fundamental research interest in the *who*, *what*, *where*, and *when* of Jesuit science, but also enables me to explore the research data in a more direct, data-driven way, opening the door to further investigations and follow-up projects as seen in Chapter 5. What is more, it adds an extra layer of stability and independence from the Person Data Repository.

Towards the end of my remarks, I would now like to circle back to the very introduction in Chapter 1 and revisit the quote printed there. Its last part relates the apprehensions that some historians have about digital historical scholarship, namely that "the computer [...] rather brings the danger of superficiality and de-scholarlification than advantages or even changes for 'real historical scholarship'"[3] As I hope to prove with the Jesuit Science Network and its description and explanation in my thesis, these apprehensions are unfounded. With the digital implementation of the JSN firmly rooted in a historical account of Jesuit scholars in the early modern sciences, there simply is no place for superficiality or de-scholarlification, as the novel digital components of my work depend in their very structure and design on the fundamentally historical research interest. The use of digital methods does not change traditional scholarship as much as it extends it, providing new opportunities for exploration, presentation, and interpretation,

3. "[D]er Computer [...] brächte eher die Gefahr der Oberflächlichkeit und Entwissenschaftlichung als Vorteile oder gar Veränderungen für die ‚echte Geschichtsforschung'," Rehbein, Sahle, and Vogeler, "Virtuelle Grenzen der Geschichtswissenschaft. Stand und Perspektiven der digitalen Geschichtsforschung", see also Chapter 1.

and as such bringing a certain materiality with it despite being virtual. And since all is based on the rigorous study of historical sources and literature, digital history is just as valid as "real historical scholarship" is.

Chapter 7.

Bibliography

Literature before 1800

Alstedt, Johann Heinrich. *Encyclopaedia*. Edited by Wilhelm Schmidt-Biggemann. Stutt-/gart / Bad Cannstatt: Frommann-Holzboog, 1989–1990 [1630].

Barrow, Isaac. *The usefulness of mathematical learning explained and demonstrated*. London, 1734.

Clavius, Christoph. *Euclidis Elementorum libri XV*. 1574.

———. "Modus quo disciplinae mathematicae in scholis Societatis possent promoveri". In *Monumenta Paedagogica Societatis Jesu Quae primam Ratiomem Studiorum anno 1586 editam praecessere*, edited by Caecilius Gomez Rodeles, Marianus Lecina, Vincentius Agusti, Fridericus Cervos, and Aloisius Ortiz, pp. 471–474. Madrid: Institutum Historicum Societatis Iesu, 1901 [1582].

Consilium de recuperanda et in posterum stabilienda pace Regni Poloniae. In quo demonstratur pacem nec constitui nec stabiliri posse, quamdiu Jesuitae in Polonia maneant. Ad illustres Regni Poloniae proceres. 1606.

Constitutiones Societatis Iesu. Cum earum Declarationibus. Romae: In collegio Romano eiusdem Societatis, 1615.

de Torres, Balthasar. "Ordo lectionis matheseos in Collegio Romano". In *Monumenta Paedagogica Societatis Iesu*, edited by Ladislaus Lukács, vol. II, pp. 433–435. Roma: Institutum Historicum Societatis Iesu, 1974 [1557–1560].

Equitis Poloni In Iesuitas Actio Prima. 1591.

Kästner, Abraham Gotthelf. *Anfangsgründe der Mathematik / 1,1: Anfangsgründe der Arithmetik, Geometrie, ebenen und sphärischen Trigonometrie und Perspectiv*. Vierte vermehrte Auflage. Göttingen: Vandenhoek, 1786.

Kochánnski, Adamus Adamandus. *Analecta Mathematica, sive Theoreses Mechanicae Novae. De natura quinque fundamentalium; et de novo motionum machinalium Principio Universali et unico; nec non de Motus artificialis perpetui possibilitate*. In *Cursus mathematicus sive absoluta omnium mathematicarum disciplinarum encyclopaedia*, by Gaspar Schott, pp. 621–657. Herbipoli; Francofurti: Schönwetter; Herbipoli: Hertz, 1661.

Legipontius, Oliverius, and Magnoaldus Ziegelbauer. *Historia rei literariae Ordinis S. Benedicti*. Augustæ Vind. [etc.] : Sumptibus Martini Veith, 1754.

Newe Zeyttung, Waarhaffte Histori von der Mörderischen unnd erbärmblichen that, so durch die Jesuwiter zü Crackauw in Polen geschehen, und wie sy darumb ihren verdienten lon empfangen. Gdańsk: Jacob Roth, 1586.

Paul III. "Bulla Prima Pauli III". In *Monumenta Ignatiana ex autographis vel ex antiquioribus exemplis collecta*, vol. I, pp. 24–32. Roma: Institutum Historicum Societatis Iesu, 1934 [1540].

Pereira, Benito. *De Communibus omnium rerum naturalium principiis et Affectionibus, libri quindecim*. 1579.

Privata Monita Societatis Jesu. Notobirga, 1614.

Richeome, Louis. *La peinture spirituelle*. 1611.

Trepka, Walerian Nekanda. *Liber Generationis Plebeanorum (Liber chamorum)*. Edited by Włodzimierz Dworzaczek, Julian Bartyś, and Zbigniew Kuchowicz. Wrocław: Zakład Narodowy imienia Ossolińskich, 1963 [1626].

Zahorowski, Hieronym. *Secreta monita Societatis Jesu = The secret instructions of the Jesuits.* London: Printed for J. Walthoe; and sold by M. Cooper, 1746.

Literature after 1800

Aristotle. *Posterior analytics*. Edited by Jonathan Barnes. Clarendon Press. Translated with a commentary by Jonathan Barnes.

Asche, Matthias. "Kollegien, Kompetenz und Kostenkalkül – jesuitische Erfolgsrezepte an Universitäten im Konfessionellen Zeitalter". In *Historisches Jahrbuch*, edited by Karl-Heinz Braun, Thomas Brechenmacher, Wilhelm Damberg, Franz J. Felten, Hans Günter Hockerts, Christoph Kampmann, Hans-Michael Körner, and Anton Schindling, pp. 57–75. München: Verlag Karl Alber Freiburg, 2013.

Ashworth, Jr., William B. "Light of Reason, Light of Nature: Catholic and Protestant Metaphors of Scientific Knowledge". *Science in Context* 3, no. 1 (1989): pp. 89–107.

Aspaas, Per Pippin. *Maximilianus Hell (1720-1792) and the Eighteenth-Century Transits of Venus : A Study of Jesuit Science in Nordic and Central European Contexts*. Tromsø: Tromsø Universitetet, 2012.

Augustyniak, Urszula. "‚Wolę mieć *religionem frigidam* niż *nullam*'. Jerzy i Krzysztof Zbarascy wobec rekatolicyzacji i zmiany systemu rządów w Rzeczypospolitej za Zygmunta III Wazy". *Odrodzenie i Reformacja w Polsce* LVIII (2014): pp. 73–104.

———. *History of the Polish-Lithuanian Commonwealth : State – Society – Culture*. Edited by Iwo Hryniewicz. Frankfurt am Main: Peter Lang, 2015.

Ayers, Edward, David Bell, Peter Bol, Timothy Burke, Seth Denbo, James Gregory, Claire Potter, Janice Reiff, and Kathryn Tomasek. "Guidelines for the Professional Evaluation of Digital Scholarship by Historians". American Historical Association. July 2015.

Bajerowa, Irena. "Jezuici w dziejach języka polskiego". In *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, edited by Irena Stasiewicz-Jasiukowa, pp. 427–448. Kraków: Wydawnictwo NAM, 2004.

Baldini, Ugo. *Legem impone subactis : Studi su filosofia e scienza dei Gesuiti in Italia : 1540–1632*. Roma: Bulzoni Editore, 1992.

———. "The Academy of Mathematics of the Collegio Romano from 1553 to 1612". In *Jesuit Science and the Republic of Letters*, edited by Mordechai Feingold, pp. 47–98. Cambridge: The MIT Press, 2003.

Baldini, Ugo. "The Jesuit College in Macao as a meeting point of the European, Chinese and Japanese mathematical traditions. Some remarks on the present state of research, mainly concerning sources (16th–17th centuries)". In *The Jesuits, the Padroado and East Asian Science (1552–1773)*, edited by Luís Saraiva and Catherine Jami, pp. 33–79. Singapore: World Scientific Publishing, 2008.

———. "The teaching of Mathematics in the Jesuit Colleges of Portugal, from 1640 to Pombal". In *The Practice of Mathematics in Portugal*, edited by Luís Saraiva and Henrique Leitão, pp. 293–465. Coimbra: Universidade de Coimbra, 2004.

Baldwin, Martha. "Pious Ambition: Natural Philosophy and the Jesuit Quest for the Patronage of Printed Books in the Seventeenth Century". In *Jesuit Science And The Republic Of Letters*, edited by Mordechai Feingold, pp. 285–329. Cambridge: The MIT Press, 2003.

Batllori, M. "Cerdà, Tomás". In *Diccionario histórico de la Compañía de Jesús*, edited by Charles O'Neill, vol. I, cols. 734–735. Madrid: Universidad Pontifica Comillas, 2001.

Bednarski, Stanisław. *Upadek i odrodzenie szkół jezuickich w Polsce*. Kraków: Wydawnictwo Księży Jezuitów, 1933.

Beel, Joeran, Bela Gipp, and Erik Wilde. "Academic Search Engine Optimization (ASEO): Optimizing Scholarly Literature for Google Scholar and Co." *Journal of Scholarly Publishing* 41, no. 2 (2010): pp. 176–190.

Bennett, Jim. "The Mechanical Arts". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 632–695. Cambridge: Cambridge University Press, 2006.

"Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities". `https://openaccess.mpg.de/Berliner-Erklaerung`. Published 10/22/2003, accessed 09/26/2017.

Besterman, Theodore, ed. *A world bibliography of bibliographies and of bibliographical catalogues, calendars, abstracts, digests, indexes, and the like*. Fourth edition, second printing. Rowman / Littlefield, 1971.

Bieńkowska, Barbara. "From negation to acceptance : The reception of the heliocentric theory in Polish Schools in the 17th and 18th centuries". In *The reception of Copernicus' heliocentric theory : Proceedings of a symposium organized by the Nicolas Copernicus Committee of the International Union of the History and Philosophy of Science*, edited by Jerzy Dobrzycki, pp. 79–116. Dordrecht: Reidel, 1972.

Biermann, Felix Paul. "Überzeugung und Zwang bei der Christianisierung Polens unter den ersten Piasten". In *Schwertmission : Gewalt und Christianisierung im Mittelalter*, edited by Hermann Kamp and Martin Kroker, pp. 67–92. Paderborn: Ferdinand Schöningh, 2013.

Bieś, Andrzej Paweł. "Periodyzacja obecności Towarzystwa Jezusowego na ziemiach polskich. Struktury organizacyjne oraz edukacyjno-oświatowe i pastoralne formy aktywności". *Studia Pedagogica Ignatiana* 17 (2014): pp. 57–87.

Blair, Ann. "Natural Philosophy". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 365–406. Cambridge: Cambridge University Press, 2006.

Blum, Paul Richard. *Studies on Early Modern Aristotelianism*. Brill, 2012.

Bömelburg, Hans-Jürgen. "Sarmatismus – Zur Begriffsgeschichte und den Chancen und Grenzen als forschungsleitender Begriff". *Jahrbücher für Geschichte Osteuropas* 57, no. 3 (2009): pp. 402–408.

Borgman, Christine L. *Scholarship in the Digital Age : Information, Infrastructure, and the Internet*. Cambridge, Massachusetts: MIT Press, 2007.

Boswell, Grant. "Letter Writing among the Jesuits: Antonio Possevino's Advice in the 'Bibliotheca Selecta' (1593)". *Huntington Library Quarterly* 66, nos. 3/4 (2003): pp. 247–262.

Bowler, Peter. "The Popularisation of Science". Leibniz Institute of European History (IEG). 2015. `http://www.ieg-ego.eu/bowlerp-2015-en`. Accessed 09/26/2017.

Brooke, John Hedley. "Science and Religion". In *The Cambridge History of Science*, edited by Roy Porter, vol. 4, pp. 741–761. Cambridge: Cambridge University Press, 2003.

Brown, Susan, Patricia Clements, Isobel Grundy, Stan Ruecker, Jeffery Antoniuk, and Sharon Balazs. "Published Yet Never Done: The Tension Between Projection and Completion in Digital Humanities Research". *DHQ: Digital Humanities Quarterly* (2009).

Buchwald-Pelcowa, Paulina. *Cenzura w dawnej Polsce*. Warszawa: Wydawnictwo SBP, 1997.

Burdick, Anne, Johanna Drucker, Peter Lunenfeld, Todd Presner, and Jeffrey Schnapp. *Digital_Humanities*. Cambridge: The MIT Press, 2012.

Butterwick-Pawlikowski, Richard. "Before and After Suppression : Jesuits and Former Jesuits in the Polish-Lithuanian Commonwealth, c. 1750–1795". In *Jesuit Survival and Restoration : A Global History, 1773–1900*, edited by Robert A. Maryks and Jonathan Wright, pp. 49–66. Leiden: Brill, 2015.

"Call for Papers for the dhnord2017". 2017. `https://dhnord2017.sciencesconf.org/resource/page/id/1`. Accessed 09/26/2017.

Cantor, Moritz. *Vorlesungen über Geschichte der Mathematik*. Zweite Auflage. Vol. 2. Leipzig: B. G. Teubner, 1900.

Carayon, Auguste, ed. *Bibliographie historique de la Compagnie de Jésus ou catalogue de ouvrages relatifs à l'histoire des jésuites depuis leur origine jusqu'à nos jours par le P. Auguste Carayon de la même Compagnie*. Paris: Auguste Durand, 1864.

Carolino, Luís Miguel. "Cristoforo Borri and the epistemological status of mathematics in seventeenth-century Portugal". *Historia Mathematica* 34, no. 2 (2007): pp. 187–205.

Carolino, Luís Miguel, and Henrique Leitão. "Natural Philosophy and Mathematics in Portuguese Universitites, 1550–1650". In *Universities and Science in the Early Modern Period*, edited by Mordechai Feingold and Victor Navarro-Brotóns, pp. 153–168. Dordrecht: Springer, 2006.

Carrigan, Mark. *Social Media for Academics*. Sage, 2016.

Ceynowa, Klaus, and Lilian Landes. "Neuer Wein in neuen Schläuchen : Von Wissenschaftlern, die nicht nur anders publizieren, sondern auch anders schreiben werden". *Bibliothek Forschung und Praxis* 38, no. 2 (2014): pp. 287–293.

Chruszczewski, Adam. "Les Ordres Religieux en Pologne au XVIIe et au XVIIIe s." In *Le millénaire du catholicisme en Pologne = Poland's millennium of Catholicism*, edited by Marian Rechowicz, pp. 119–125. Lublin: Towarzystwo Naukowe Katolickiego Uniwersytetu Lubelskiego, 1969.

Clark, William. "The Pursuit of the Prosopography of Science". In *The Cambridge History of Science*, edited by David C. Lindberg, Mary Jo Nye, Roy Porter, and Theodore M. Porter, vol. 4, pp. 211–237. Cambridge: Cambridge University Press, 2003.

Codina, Gabriel. "The 'Modus Parisiensis'". In *The Jesuit Ratio Studiorum : 400th Anniversary Perspectives*, edited by Vincent J. Duminuco, pp. 28–49. New York: Fordham University Press, 2000.

Cohen, Edward L. "Adoption and Reform of the Gregorian Calendar". *Math Horizons* 7, no. 3 (2000): pp. 5–11.

Cohen, Floris. *Die zweite Erschaffung der Welt. Wie die moderne Naturwissenschaft entstand*. Bonn: bpb, 2011.

———. *The Scientific Revolution : A Historiographical Inquiry*. Chicago: The University of Chicago Press, 1994.

Correia-Afonso, J. "Storer, Franz". In *Diccionario Histórico de la Compañía de Jesús*, edited by Charles O'Neill et al., vol. IV, col. 3644. Madrid: Universidad Pontifica Comillas, 2001.

Cosentino, Giuseppe. "Mathematics in the Jesuit Ratio Studiorum". In *Church, culture, and curriculum: theology and mathematics in the Ratio studiorum*, edited by Frederick A. Homann, pp. 47–80. Philadelphia: Saint Joseph's University Press, 1999.

Coyne, G. V., M. A. Hoskin, and O. Pedersen, eds. *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*. Pontificia Academia Scientarum, Specola Vaticana, 1983.

Cozzoli, Daniele. "Alessandro Piccolomini and the certitude of mathematics". *History and Philosophy of Logic* 28, no. 2 (2007): pp. 151–171.

Dąbkowska-Kujko, Justyna. "Jezuicka paideia". In *Humanitas i christianitas w kulturze polskiej*, edited by M. Hanusiewicz-Lavallee, pp. 153–190. Warszawa: Wydawnictwo Neriton, 2009.

DaCosta Kaufmann, Thomas. *Court, Cloister, and City : The Art and Culture of Central Europe 1450–1800*, edited by Jan K. Ostrowski et al., pp. 15–25. Chicago: The University of Chicago Press, 1995.

———. "Definition and Self-Definition in Polish Culture and Art". In *Land of the Winged Horsemen : Art in Poland 1572–1764*, edited by Jan K. Ostrowski et al., pp. 15–25. Alexandria, Virginia: Art Services International in association with Yale University Press, 1999.

Dalton, Susan. *Engendering the Republic of Letters : Reconnecting Public anc Private Spheres in Eighteenth-Century Europe*. Montreal: McGill-Queen's University Press, 2003.

Danieluk, Robert. *La Bibliothèque de Carlos Sommervogel: Le sommet de l'œvre bibliographique de la Compagnie de Jésus (1890–1932)*. Institutum Historicum Societatis Iesu, 2006.

"Das Impressum im Internet : Ein Leitfaden für die Anbieterkennzeichnung auf Websites". E-Commerce-Verbindungsstelle Deutschland. 2014.

Davies, Norman. *God's Playground: A History of Poland*. Vol. I. Oxford: Clarendon Press, 1981.

de Asúa, Miguel. "Jesuit Science in the Missions of Paraguay and Río de la Plata". In *Latin American Perspectives on Science and Religion*, edited by Ignacio Silva, pp. 71–84. London: Routledge, 2014.

De Backer, Augustin and Aloïs, ed. *Bibliothèque des écrivains de la Compagnie de Jésus, ou notices bibliographiques: 1. de tous les ouvrages publiés par les membres de la compagnie de Jésus depuis la fondation de l'ordre jusqu'à nos jours; 2. des apologies, des controverses religieuses, des critiques littéraires et scientifiques suscitées à leur sujet, par Augustin et Aloïs De Backer de la même Compagnie*. VI vols. Lièges: L. Grandmont-Donders, 1853–1861.

de Bruycker, Angelo. "'To the adornment and honour of the city': the mathematics course of the Flemish Jesuits in the seventeenth century". *BSHM Bulletin* 24, no. 3 (2009): pp. 135–146.

de Dalmases, C. "Torres, Baltasar de (I)". In *Diccionario histórico de la Compañía de Jesús*, edited by Charles O'Neill, vol. IV, col. 3818. Madrid: Universidad Pontifica Comillas, 2001.

De Jonge, Krista. "The First Jesuit Schools in the Southern Low Countries 1585–1648". In *Public buildings in early modern Europe*, edited by Koen A. Ottenheym, pp. 307–324. Turnhout: Brepols, 2010.

de Lucca, Denis. *Jesuits and Fortifications : The Contribution of the Jesuits to Military Architecture in the Baroque Age*. Leiden: Brill, 2012.

Dear, Peter. *Discipline & Experience*. Chicago: The University of Chicago Press, 1995.

———. "Jesuit mathematical science and the reconstitution of experience in the early seventeenth century". *Studies in History and Philosophy of Science* 8 (2 1987): pp. 133–175.

———. *Revolutionizing the Sciences : European Knowledge and Its Ambitions, 1500–1700*. Princeton: Princeton University Press, 2009.

———. "The Meanings of Experience". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 106–131. Cambridge: Cambridge University Press, 2006.

"Digital Amnesia". IG Rote Fabrik. December 2016. `http://www.fabrikzeitung.ch/category/digital-amnesia/`. Accessed 09/26/2017.

Dinis, Alfredo. "Giovanni Battista Riccioli and the Science of His Time". In *Jesuit Science and the Republic of Letters*, edited by Mordechai Feingold, pp. 195–224. Cambridge: The MIT Press, 2003.

Dobusch, Leonhard, and Valie Djordjevic, eds. *Generation Remix : Zwischen Popkultur und Kunst*. iRights.Media, 2014.

Donohue, John. *Jesuit Education*. New York: Fordham University Press, 1963.

Dormus, Katarzyna, Bożena Popiołek, Agnieszka Chłosty-Sikoska, and Ryszard Ślęczki, eds. *Komisja Edukacji Narodowej : Kontekst historyczno-pedagogiczny*. Kraków: Wydział Pegagogiczny Uniwersytetu Pedagogicznego im. Komisji Edukacji Narodowej w Krakowie, 2014.

Drake, Stillman. *Galileo: A Very Short Introduction*. Oxford: Oxford University Press, 2001.

Drzymała, K., and L. Grzebień. "Skarga, Piotr". In *Diccionario histórico de la Compañía de Jesús*, edited by Charles O'Neill, vol. IV, cols. 3588–3589. Madrid: Universidad Pontifica Comillas, 2001.

Duclos, P. "Castel, Louis-Betrand". In *Diccionario histórico de la Compañía de Jesús*, edited by Charles O'Neill, vol. I, col. 699. Madrid: Universidad Pontifica Comillas, 2001.

Duminuco, Vincent J. "A New *Ratio* for a New Millennium?" In *The Jesuit Ratio Studiorum : 400th Anniversary Perspectives*, edited by Vincent J. Duminuco, pp. 145–160. New York: Fordham University Press, 2000.

Düring, Marten. *Verdeckte soziale Netzwerke im Nationalsozialismus : Die Entstehung und Arbeitsweise von Berliner Hilfsnetzwerken für verfolgte Juden*. Berlin: De Gruyter Oldenbourg, 2015.

Düring, Marten, and Linda von Keyserlingk. "Netzwerkanalyse in den Geschichtswissenschaften. Historische Netzwerkanalyse als Methode für die Erforschung von historischen Prozessen". In *Prozesse : Formen, Dynamiken, Erklärungen*, edited by Rainer Schützeichel and Stefan Jordan, pp. 337–350. Wiesbaden: Springer, 2015.

Düring, Marten, Ulrich Eumann, Martin Stark, and Linda von Keyserlingk, eds. *Handbuch Historische Netzwerkforschung*. Berlin: LIT, 2016.

Engelfriet, Peter. *Euclid in China. The Genesis of the First Translation of Euclid's Elements in 1607 & its Reception up to 1723*. Leiden: Brill, 1998.

Faber, Martin. "Das Streben des polnischen Adels nach dem Erhalt seiner Privilegien : Zur ursprünglichen Bedeutung des Wortes ‚Sarmatismus'". *Jahrbücher für Geschichte Osteuropas* 57, no. 3 (2009): pp. 374–401.

Falcon, Andrea. "Aristotle on Causality". In *The Stanford Encyclopedia of Philosophy*, Spring 2015, edited by Edward N. Zalta. Stanford: Stanford University, 2015. `https://plato.stanford.edu/archives/spr2015/entries/aristotle-causality/`.

Feingold, Mordechai, ed. *Jesuit Science and the Republic of Letters*. Cambridge: The MIT Press, 2003.

———, ed. *The New Science and Jesuit Science: Seventeenth Century Perspectives*. Dordrecht: Springer-Science+Business Media, B.V, 2003.

Findlen, Paula. "Living in the Shadow of Galileo: Antonio Baldigiani (1647–1711), a Jesuit Scientist in Late Seventeenth-Century Rome". In *Conflicting Duties: Science, Medicine and Religion in Rome, 1550–1750*, edited by Maria Pia Donato and Jill Kraye, pp. 211–254. London and Turin: The Warburg Institute / Nino Aragno Editore, 2009.

Fischer, K. "Appended Note: On the Calendar Reform in Bohemia and Moravia". In *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, edited by G. V. Coyne, M. A. Hoskin, and O. Pedersen, pp. 281–284. Pontificia Academia Scientarum, Specola Vaticana, 1983.

Fischer, Karl. "Die Jesuiten-Mathematiker des nordostdeutschen Kulturgebietes". *Archives internationales d'histoire des sciences* 34, no. 112 (1984): pp. 124–162.

———. "Jesuiten-Mathematiker in der deutschen Assistenz bis 1773". *Archivum Historicum Societatis Iesu* 47 (1978): pp. 159–224.

———. "Jesuiten-Mathematiker in der französischen und italienischen Assistenz bis 1762 bzw. 1773". *Archivum Historicum Societatis Iesu* 52 (1983): pp. 52–92.

Fishkin, Rand, and Moz Staff. "The Beginner's Guide to SEO". Moz. 2015. `https://moz.com/beginners-guide-to-seo`. Accessed 09/26/2017.

Fletcher, John Edward. *A Study of the Life and Works of Athanasius Kircher, "Germanus Incredibilis"*. Edited by Elizabeth Fletcher. Brill, 2011.

Freidson, Eliot. *Professional Powers : A Study of the Institutionalization of Formal Knowledge*. Chicago and London: The University of Chicago Press, 1986.

Friedrich, Markus. *Die Jesuiten*. München/Berlin: Piper, 2016.

Frost, Robert I. "The Nobility of Poland-Lithuania, 1569–1795". In *The European nobilities in the seventeenth and eighteenth centuries*, edited by Hamish M. Scott, vol. 2, pp. 183–222. London: Longman, 1995.

Gamper, Markus, Linda Reschke, and Marten Düring, eds. *Knoten und Kanten III : Soziale Netzwerkanalyse in Geschichts- und Politikforschung*. Bielefeld: transcript Verlag, 2015.

Ganss, George E. *Saint Ignatius' Idea of a Jesuit University*. Milwaukee: Marquette University Press, 1954.

Garber, Daniel. "Philosophia, Historia, Mathematica: Shifting Sands in the Disciplinary Geography of the Seventeenth Century". In *Scientia in Early Modern Philosophy*, edited by Tom Sorell, G.A. Rogers, and Jill Kraye, pp. 1–17. Dordrecht Heidelberg London New York: Springer, 2010.

Garber, Daniel. "Physics and Foundations". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 21–69. Cambridge: Cambridge University Press, 2006.

Garbowski, Christopher. *Religious Life in Poland : History, Diversity and Modern Issues*. Jefferson, North Carolina: McFarland, 2014.

Gardner, Brian, Lauren Mancke, and Rebecca Gill. "A Beginner's Guide to SEO that Works". Episode of the podcast rainmaker.fm, transcript available online. August 2016. `http://rainmaker.fm/audio/studiopress/rebecca-gill/`. Accessed 09/26/2017.

Gast, Holger. "Zum Umgang mit Datenbanken in den Geschichtswissenschaften". In *Jahrbuch für Universitätsgeschichte*, edited by Oliver Auge and Swantje Piotrowski, pp. 233–250. Stuttgart: Franz Steiner Verlag, 2013.

Gatto, Romano. "Christoph Clavius' 'Ordo Servandus in Addiscendis Disciplinis Mathematicis' and the Teaching of Mathematics in Jesuit Colleges at the Beginning of the Modern Era". *Science & Education* 15 (2006): pp. 235–258.

Gaukroger, Stephen. "The Unity of Natural Philosophy and the End of *Scientia*". In *Scientia in Early Modern Philosophy*, edited by Tom Sorell, G.A.J. Rogers, and Jill Kraye, pp. 19–33. Dordrecht Heidelberg London New York: Springer, 2010.

Gehrke, Roland. "Die Aufhebung des Jesuitenordens und ihre Folgen für die Leopoldina". In *Die tolerierte Universität : 300 Jahre Universität Breslau 1702 bis 2002*, edited by Norbert Conrads. Stuttgart: Franz Steiner Verlag, 2004.

Giard, Luce. "The Jesuit College. A Center for Knowledge, Art, and Faith 1548–1773". *Studies in the Spirituality of Jesuits* 40 (2008): pp. 1–31.

Gierl, Martin. "Disziplinen, gelehrte". In *Enzyklopädie der Neuzeit*, edited by Friedrich Jaeger, vol. 2, pp. 1064–1069. Stuttgart: Wissenschaftliche Buchgesellschaft, 2005.

Gierowski, Józef Andrzej. "The international position of Poland in the seventeenth and eighteenth centuries". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 223–238. Cambridge: Cambridge University Press, 1982.

Gieysztorowa, Irena. "Research into the Demographic History of Poland : A Provisional Summing-Up". *Acta Poloniae Historica* 18 (1968): pp. 5–17.

Gingerich, O. "The Civil Reception of the Gregorian Calendar". In *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, edited by G. V. Coyne, M. A. Hoskin, and O. Pedersen, pp. 265–279. Pontificia Academia Scientarum, Specola Vaticana, 1983.

Golvers, Noël. "F. Verbiest's mathematical formation. Some observations on post-Clavian Jesuit mathematics in mid-17th century Europe". *Archives internationales d'histoire des sciences* 54 (2004): pp. 29–47.

"Google Search Engine Optimization Starter Guide". Google. Licensed under Creative Commons Attribution 3.0. 2010. `http://www.google.co.jp/intl/en/webmasters/docs/search-engine-optimization-starter-guide.pdf`. Accessed 09/26/2017.

Gorman, Michael John. "The scientific counter-revolution. Mathematics, natural philosophy and experimentalism in Jesuit culture. 1580–c.1670". PhD diss., European University Instutute, 1998.

Graf, Klaus. "Dissertationsdruckzwang". `http://archivalia.hypotheses.org/66830`. Published 08/18/2017, accessed 08/21/2017.

Gregory, Ian N., and Paul S. Ell. *Historical GIS : Technologies, Methodologies and Scholarship*. Cambridge: Cambridge University Press, 2007.

Gregory, Ian N., and Richard G. Healey. "Historical GIS: structuring, mapping and analysing geographies of the past". *Progress in Human Geography* 31, no. 5 (2007): pp. 638–653.

Grendler, Paul F. "Jesuit Schools in Europe. A Historiographical Essay". *Journal of Jesuit Studies* 1 (2014): pp. 7–25.

Grochulska, Barbara. "The place of the Enlightenment in Polish social history". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 244–257. Cambridge: Cambridge University Press, 1982.

Grünwald, Michael. "Forschen – P. Oliver Legipont (1698–1758) aus Groß St. Martin und seine Beziehungen zur Abtei Göttweig". In *Benediktinisches Leben in Köln*, edited by Marcel Albert, pp. 119–143. Siegburg: Verlag Franz Schmitt, 2010.

Grzebień, L., and L. Piechnik. "Polonia". In *Diccionario histórico de la Compañía de Jesús*, edited by Charles O'Neill, vol. IV, cols. 3173–3187. Madrid: Universidad Pontifica Comillas, 2001.

Grzebień, Ludwik. "Dotychczasowa literatura o wkładzie jezuitów polskich do nauki i kultury". In *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, edited by Irena Stasiewicz-Jasiukowa, pp. 31–68. Kraków: Wydawnictwo NAM, 2004.

———. *Podstawowa bibliografia do dziejów Towarzystwa Jezusowego w Polsce*. Vol. 1. Kraków: Wydawnictwo WAM, 2009.

———. *Podstawowa bibliografia do dziejów Towarzystwa Jezusowego w Polsce*. Vol. 2. Kraków: Wydawnictwo WAM, 2009.

———. "Znaczenie jezuitów w Rzeczypospolitej na przełomie XVI i XVII w." *Studia Bobolanum* 3 (2010): pp. 37–54.

Grzebień, Ludwik, et al., eds. *Encyklopedia wiedzy o Jezuitach na ziemiach Polski i Litwy 1564–1995*. Kraków: Wydawnictwo NAM, 2004.

Haber, Peter. *Digital Past : Geschichtswissenschaft im digitalen Zeitalter*. München: Oldenbourg Verlag, 2011.

———. "Zeitgeschichte und Digital Humanities, Version 1.0". 2012. `http://docupedia.de/zg/Digital_Humanities?oldid=106224`. Published 09/24/2012, accessed 09/26/2017.

Haber, Peter, and Eva Pfanzelter. *historyblogosphere : Bloggen in den Geschichtswissenschaften*, pp. 37–49. München: Oldenbourg Verlag, 2013.

Harris, Steven. "Confession-Building, Long-Distance Networks, and the Organization of Jesuit Science". *Early Science and Medicine* 1, no. 3 (1996): pp. 287–318.

———. "Jesuit ideology & Jesuit science: Scientific activity in the Society of Jesus, 1540-1773". PhD diss., University of Wisconsin-Madison, 1988.

———. "Jesuit Scientific Activity in the Overseas Missions, 1540–1773". *Isis* 96 (2005): pp. 71–79.

———. "Les chaires de mathématiques". In *Les Jésuites à la Renaissance*, edited by Luce Giard, pp. 239–261. Paris: Presses Universitaires de France, 1997.

———. "Transposing the Merton Thesis: Apostolic Spirituality and the Establishment of the Jesuit Scientific Tradition". *Science in Context* 3 (1989): pp. 29–65.

Hartmann, Peter C. *Die Jesuiten*. München: C.H. Beck, 2008.

Heilbron, J. L. "History of science". In *The Oxford Companion to the History of Modern Science*, edited by J. L. Heilbron et al., pp. 370–374. Oxford: Oxford University Press, 2003.

Heilbron, John. *Galileo*. Oxford: Oxford University Press, 2010.

Hellyer, Marcus. "'Because the Authority of My Superiors Commands': Censorship, Physics and the German Jesuits". *Early Science and Medicine* 1 (3 1996): pp. 319–354.

Henry, John. "Religion and the Scientific Revolution". In *The Cambridge Companion to Science and Religion*, edited by Peter Harrison, pp. 39–58. Cambridge: Cambridge University Press, 2010.

Hoskin, M. A. "The Reception of the Calendar by Other Churches". In *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, edited by G. V. Coyne, M. A. Hoskin, and O. Pedersen, pp. 255–264. Pontificia Academia Scientarum, Specola Vaticana, 1983.

Hsia, Florence C. *Sojourners in a strange land : Jesuits and their scientific missions in late imperial China*. Chicago: The University of Chicago Press, 2009.

Hübner, Marita. "Professionalisierung : Wissenschaft". In *Enzyklopädie der Neuzeit*, edited by Friedrich Jaeger, vol. 10, pp. 439–442. Stuttgart: Wissenschaftliche Buchgesellschaft, 2009.

Hufton, Olwen. "Every Tub on Its Own Bottom: Funding a Jesuit college in Early Modern Europe". In *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, edited by John O'Malley, pp. 5–23. Toronto: University of Toronto Press, 2006.

Hymes, Dell H., ed. *The Use of Computers in Anthropology*. The Hague: Mouton, 1965.

Inglot, Marek. "The Society of Jesus in the Russian Empire (1772–1820) and the Restoration of the Order". In *Jesuit Survival and Restoration : A Global History, 1773–1900*, edited by Robert A. Maryks and Jonathan Wright, pp. 67–82. Leiden: Brill, 2015.

Jamali, Hamid R., David Nicholas, and Eti Herman. "Scholarly reputation in the digital age and the role of emerging platforms and mechanisms". *Research Evaluation* 25, no. 1 (2016): pp. 37–49.

Jannidis, Fotis. "Grundlagen der Datenmodellierung". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 99–108. Stuttgart: J.B. Metzler, 2017.

Joy, Lynn S. "Scientific Explanation from Formal Causes to Laws of Nature". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 70–105. Cambridge: Cambridge University Press, 2006.

Kaden, Ben, and Michael Kleineberg. "Zur Situation des digitalen geisteswissenschaftlichen Publizierens – Erfahrungen aus dem DFG-Projekt ‚Future Publications in den Humanities'". *Bibliothek Forschung und Praxis* 41, no. 1 (2017): pp. 7–14.

Kadulska, Irena. "The Połock Academy (1812–1820) : An Example of the Society of Jesus's Endurance". In *Jesuit Survival and Restoration : A Global History, 1773–1900*, edited by Robert A. Maryks and Jonathan Wright, pp. 83–98. Leiden: Brill, 2015.

Karp, Alexander, and Gert Schubring. "Mathematics Education in Europe in the Premodern Times". Chap. 7 in *Handbook on the History of Mathematics Education*, edited by Alexander Karp and Gert Schubring, pp. 129–151. New York: Springer, 2014.

Kennedy, T. Frank. "Music and Jesuits: Historiography, and a Global Perspective". *Journal of Jesuit Studies* 3 (2016): pp. 365–376.

Kirschenbaum, Matthew G. "Done: Finishing Projects in the Digital Humanities". *DHQ: Digital Humanities Quarterly* 3, no. 2 (2009).

Klimpel, Paul, and Jürgen Kneiper, eds. *Was bleibt? Nachhaltigkeit der Kultur in der digitalen Welt*. i.Rights Media, 2013.

Klimpel, Paul, and John H. Weitzmann. "Forschen in der digitalen Welt : Juristische Handreichung für die Geisteswissenschaften". GOEDOC, Dokumenten- und Publikationsserver der Georg-August-Universität Göttingen. 2015. `http://resolver.sub.uni-goettingen.de/purl/?dariah-2015-5`. Accessed 09/26/2017.

Klinke, Harald. "Datenbanken". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 109–127. Stuttgart: J.B. Metzler, 2017.

Kloczowski, Jerzy. *A History of Polish Christianity*. Cambridge: Cambridge University Press, 2000.

Knobloch, Eberhard. "Kaspar Schott's 'encyclopedia of all mathmatical sciences'". *Poiesis Prax* 7 (2011): pp. 225–247.

Kochanowicz, Jerzy. "Źródła do dziejów oświaty jezuickiej okresu staropolskiego". In *Źródła w badaniach naukowych historii edukacji*, pp. 15–42. Toruń: Wydawnictwo Naukowe UMK, 2003.

Kohle, Hubertus. "Digitales Publizieren". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 199–205. Stuttgart: J.B. Metzler, 2017.

Komorowska, Magdalena. "In the Eye of the Storm: Books in the Conflict between the Jesuits and the University of Kraków (1622–1634)". In *Publishing Subversive Texts in Elizabethan England and the Polish-Lithuanian Commonwealth*, edited by Teresa Bela, Clarinda Calma, and Jolanta Rzegocka, pp. 56–71. Leiden: Brill, 2016.

König, Mareike. "Was sind Digital Humanities? Definitionsfragen und Praxisbeispiele aus der Geschichtswissenschaft". Digital Humanities am DHIP. 2016. `http://dhdhi.hypotheses.org/2642`. Published 17/02/2016, updated 19/02/2016, accessed 09/26/2017.

Kościelak, Sławomir. "Jezuici w trzech wielkich miastach pruskich w XVI-XVIII w." *Hereditas Monasteriorum* 3 (2013): pp. 155–187.

Koyré, Alexandre. *Études galiléennes*. Paris: Hermann, 1939.

Krayer, Albert. *Mathematik im Studienplan der Jesuiten*. Beiträge zur Geschichte der Universität Mainz. Stuttgart: Franz Steiner Verlag, 1991.

Kretzschmar, Jr., William A. "Large-Scale Humanities Computing Projects: Snakes Eating Tails, or Every End is a New Beginning?" *DHQ: Digital Humanities Quarterly* (2009).

Lamanna, Marco. "Mathematics, Abstraction and Ontology: Benet Perera and the Impossibility of a Neutral Science of Reality". *Quaestio*, no. 14 (2014): pp. 69–89.

Lattis, James M. *Between Copernicus and Galileo*. Chicago: The University of Chicago Press, 1994.

Leitão, Henrique. "Jesuit Mathematical Practice in Portugal, 1540-1759". In *The New Science and Jesuit Science : Seventeenth Century Perspectives*, edited by Mordechai Feingold, vol. 12, pp. 229–248. Archimedes. Dordrecht: Kluwer Academic Publishers, 2003.

Leitão, Henrique, and Samuel Gessner. "Euclid in tiles: the mathematical azulejos of the Jesuit college in Coimbra". *Mathematische Semesterberichte* (2014).

Lemercier, Claire. "Formale Methoden der Netzwerkanalyse in den Geschichtswissenschaften: Warum und Wie?" *Österreichische Zeitschrift für Geschichtswissenschaften : Sonderheft Historische Netzwerkanalysen* 23, no. 1 (2012): pp. 16–41.

Lisiak, Bogdan. *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*. Kraków: Wyższa Szkoła Filozoficzno-Pedagogiczna Ignatianum, 2000.

———. *Nauczanie matematyki w polskich szkołach jezuickich od XVI do XVIII wieku*. Kraków: Wydawnictwo NAM, 2003.

Lisiak, Bogdan, and Ludwik Grzebień, eds. *Korespondencja Adama Adamandego Kochańskiego SJ (1657–1699)*. Kraków: Wyższa Szkoła Filozoficzno-Pedagogiczna Ignatianum, 2005.

Loach, Judi. "Revolutionary Pedagogues? How Jesuits Used Education to Change Society". In *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, edited by John O'Malley, pp. 66–85. Toronto: University of Toronto Press, 2006.

Lohr, Charles. "Aristotelian Theories of Science in the Renaissance". In *Sciences et religions de Copernic à Galilée*, edited by Catherine Brice and Antonella Romano, pp. 17–29. Rome: École Française de Rome, 1999.

Lordick, Harald. "BEACON – ‚Leuchtfeuer' für Online-Publikationen". 2015. `https://djgd.hypotheses.org/672`. Accessed 09/26/2017.

Lowenthal, Patrick, and Joanna Dunlap. "Intentional Web Presence: 10 SEO Strategies Every Academic Needs to Know". EDUCAUSEreview. `http://er.educause.edu/articles/2012/6/intentional-web-presence-10-seo-strategies-every-academic-needs-to-know`. Published 05/06/2012, accessed 09/26/2017.

Lukács, Ladislaus. "A History of the Ratio Studiorum". In *Church, culture, and curriculum: theology and mathematics in the Ratio studiorum*, edited by Frederick A. Homann, pp. 17–46. Philadelphia: Saint Joseph's University Press, 1999.

Łukaszewska-Haberkowa, Justyna. *Wpływ pierwszego pokolenia polskich Jezuitów na życie kulturalne i religijne Rzeczypospolitej Obojga Narodów w latach 1564–1608*. Kraków: Wydawnictwo WAM, 2014.

Mączak, Antoni. "The structure of power in the Commonwealth of the sixteenth and seventeenth centuries". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 113–134. Cambridge: Cambridge University Press, 1982.

Martin, A. Lynn. "Alcohol and the Clergy in Traditional Europe". In *History Has Many Voices*, edited by Lee Palmer Wandel, pp. 23–39. Kirksville: Truman State University Press, 2003.

McMullin, Ernan. "Galileo on science and Scripture". In *The Cambridge Companion to Galileo*, edited by Peter Machamer, pp. 271–347. Cambridge: Cambridge University Press, 1998.

Mercer, Christia. "The Vitality and Importance of Early Modern Aristotelianism". In *The Rise of Modern Philosophy : The Tension between the New and Traditional Philosophies from Machiavelli to Leibniz*, edited by Tom Sorell, pp. 33–67. Oxford: Clarendon Press, 1993.

Métin, Frédéric. "Quand les jésuites enseignaient la fortification". *Bulletin APMEP* 439 (2002): pp. 223–234.

Micek, Ilja. "Die Frühe Neuzeit. Definition, Methodendiskussion, Forschungstendenzen". In *Die Frühe Neuzeit in der Geschichtswissenschaft*, edited by Nada Boškovska, pp. 17–38. Paderborn: Ferdinand Schöningh, 1997.

Miłosz, Czesław. *The History of Polish Literature*. Berkeley: University of California Press, 1983.

Morrissey, Robert, ed. *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers, etc., eds. Denis Diderot and Jean le Rond d'Alembert*. Chicago: University of Chicago: ARTFL Encyclopédie Project (Spring 2013 Edition), 2013.

Mulcrone, T. F. "Schott, Gaspar (Kaspar)". In *Diccionario Histórico de la Compañía de Jesús*, edited by Charles O'Neill et al., vol. IV, cols. 3531–3532. Madrid: Universidad Pontifica Comillas, 2001.

Müller, Albert, and Wolfgang Neurath, eds. *Österreichische Zeitschrift für Geschichtswissenschaften : Sonderheft Historische Netzwerkanalysen* 23, no. 1 (2012).

Müller, Rainer. "The 'Jesuitensystem' in the university structure of early modern Germany". In *Gesuiti e università in Europa (secoli XVI–XVIII)*, edited by Paolo Brizzi and Roberto Greci, pp. 95–108. Bologna: CLUEB, 2012.

Mungello, David E., ed. *The Chinese rites controversy : Its history and meaning*. Nettetal: Steyler Verlag, 1994.

Navarro, Víctor. "Tradition and Scientific Change in Early Modern spain: The Role of the Jesuits". In *Jesuit Science and the Republic of Letters*, edited by Mordechai Feingold, pp. 331–388. Cambridge: The MIT Press, 2003.

Nemitz, Jürgen. "Wikipedia in der historischen Lehre". In *Wikipedia und Geschichtswissenschaft*, edited by Thomas Wozniak, Jürgen Nemitz, and Uwe Rohwedder, pp. 53–79. De Gruyter, 2015.

Neumann, Gerald, Fabian Körner, Torsten Roeder, and Niels-Oliver Walkowski. "Personendaten-Repositorium (PDR)". In *Berlin-Brandenburgische Akademie der Wissenschaften : Jahrbuch 2010*, pp. 320–326. Berlin: Akademie Verlag, 2010.

Nobis, H. M. "The Reaction of Astronomers to the Gregorian Calendar". In *Gregorian Reform of the Calendar: Proceedings of the Vatican Conference to Commemorate its 400th Anniversary, 1582–1982*, edited by G. V. Coyne, M. A. Hoskin, and O. Pedersen, pp. 243–254. Pontificia Academia Scientarum, Specola Vaticana, 1983.

Norman, Don. *The Design of Everyday Things*. Revised & Expanded Edition. Basic Books, 2013.

Nowak, Lucyna, et al. *Ludność. Stan i struktura demograficzno-społeczna : Narodowy Spis Powszechny Ludności i Mieszkań 2011*. Edited by Mariusz Chmielewski. Warzawa: Zakład Wydawnictw Statystycznych, 2013.

Nowak, Zbigniew. "Gdański paszkwil antyjezuicki z 1586 roku (Początki literatury antyjezuickiej w Polsce)". *Rocznik Gdański* XXV (1966): pp. 51–71.

Obirek, Stanisław. "Jesuits in Poland and eastern Europe". In *The Cambridge Companion to the Jesuits*, edited by Thomas Worcester, pp. 136–150. Cambridge: Cambridge University Press, 2008.

———. "The Jesuits and Polish Sarmatianism". In *The Jesuits : Cultures, Sciences, and the Arts. 1540–1773*, edited by John W. O'Malley, pp. 555–563. Toronto: University of Toronto Press, 1999.

O'Malley, John. *The First Jesuits*. Cambridge: Harvard University Press, 1993.

———. "The Historiography of the Society of Jesus: Where Does It Stand Today?" In *The Jesuits : Cultures, Sciences, and the Arts, 1540–1773*, edited by John O'Malley, Gavin Alexander Bailey, Steven J. Harris, and T. Frank Kennedy. Toronto: University of Toronto Press, 1999.

O'Neill, Charles, et al., eds. *Diccionario Histórico de la Compañía de Jesús*. IV vols. Madrid: Universidad Pontifica Comillas, 2001.

Paluszkiewicz, Felicjan. *Mały słownik jezuitów w Polsce*. Warszawa: Bobolanum, 1995.

Pantic, Vladimir. *Model Based Environment : A Practical Guide for Data Model Implementation with examples in PowerDesigner*. Trafford Publishing, 2013.

Park, Katherine, and Lorraine Daston, eds. *Cambridge History of Science*, vol. 3. Cambridge: Cambridge University Press, 2006.

———. "Introduction: The Age of the New". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 1–17. Cambridge: Cambridge University Press, 2006.

Paszenda, Jerzy. "Nauczanie architektury w szkołach jezuickich XVIII wieku". In *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, edited by Irena Stasiewicz-Jasiukowa, pp. 385–402. Kraków: Wydawnictwo WAM, 2004.

Pavone, Sabina. "Between History and Myth: The *Monita secreta Societatis Jesu*". In *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, edited by John W. O'Malley, Gauvin Alexander Bailey, Stefen J. Harris, and T. Frank Kennedy, pp. 50–65. Toronto: University of Toronto Press, 2006.

———. *The Wily Jesuits and the Monita secreta : The Forget Secret Instructions of the Jesuits: Myth and Reality*. Saint Louis: The Institute of Jesuit Sources, 2005.

Pavur, Claude. *The Ratio Studiorum : The Official Plan for Jesuit Education*. Saint Louis: The Institute of Jesuit Sources, 2005.

Pawlikowska-Brożek, Zofia. "Adam Adamandy Kochański i jego prace na tle nauki XVII. w." *Studia i materiały z dziejów nauki polskiej* 19 (1974): pp. 3–37.

———. "Matematyka w okresie reform szkolnych przed lat dwustu". *Roczniki Polskiego Towarzystwa Matematycznego. Seria 2: Wiadomości Matematyczne* 24, no. 01 (1982): pp. 95–105.

———. "Podręczniki matematyki dla polskich szkół jezuickich". In *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*, edited by Irena Stasiewicz-Jasiukowa, pp. 245–268. Kraków: Wydawnictwo NAM, 2004.

Pettegree, Andrew. *Europe in the Sixteenth Century*. Oxford: Blackwell, 2002.

Pfeifer, Barbara. "Über Zweck und Nutzen der Gemeinsamen Normdatei (GND)". In *Jahrbuch für Universitätsgeschichte*, edited by Oliver Auge and Swantje Piotrowski, pp. 251–260. Stuttgart: Franz Steiner Verlag, 2013.

Piechnik, Ludwik. "Studium matematyczne i projekt akademii wojskowej Bartłomieja Wąsowskiego". *Nasza przeszłość* 36 (1971): pp. 175–187.

Platania, Gaetano. "Two Religious Orders in Sixteenth- and Seventeenth-Century Poland: The Jesuits and the Arrival of the Capuchin Friars". In *Papacy, religious orders, and international politics in the sixteenth and seventeenth centuries*, edited by Massimo Carlo Giannini, pp. 182–209. Roma: Viella, 2013.

Principe, Lawrence. *The Scientific Revolution: A Very Short Introduction*. Oxford: Oxford University Press, 2011.

Rabin, Sheila J. "Early Modern Jesuit Science. A Historiographical Essay". *Journal of Jesuit Studies* 1 (2014): pp. 88–104.

Rädle, Fidel. "Jesuit Theatre in Germany, Austria and Switzerland". In *Neo-Latin Drama in Early Modern Europe*, pp. 185–292. Leiden: Brill, 2013.

Rankin, Alisha. "Women in Science and Medicine, 1400–1800". In *The Ashgate Companion to Women and Gender in Early Modern Europe*, edited by Allyson Poska, Katherine McIver, and Jane Couchman. Ashgate Press, 2013.

Raphael, Renée J. "Copernicanism in the Classroom: Jesuit Natural Philosophy and Mathematics after 1633". *Journal for the history of astronomy*, no. 46 (4) (2015): pp. 419–440.

Rasche, Ulrich. "Die deutschen Universitäten und die ständische Gesellschaft". In *Bilder – Daten – Promotionen : Studien zum Promotionswesen an deutschen Universitäten der frühen Neuzeit*, edited by Rüdiger vom Bruch and Lorenz Friedrich Beck, pp. 150–273. Stuttgart: Franz Steiner Verlag, 2007.

Rasmussen Neal, Diane, ed. *Social Media for Academics : A practical guide*. Oxford: Chandos Publishing, 2012.

Rehbein, Malte, Patrick Sahle, and Georg Vogeler. "Virtuelle Grenzen der Geschichtswissenschaft. Stand und Perspektiven der digitalen Geschichtsforschung". Deutscher Historikertag 2010. `http://www.historikertag.de/Berlin2010/index.php/wissenschaftliches-programm/epochenuebersicht/details/611-Malte%20Rehbein.html`. Session abstract.

Reindl, Maria. *Lehre und Forschung in Mathematik und Naturwissenschaften, insbesondere Astronomie, an der Universität Würzburg von der Gründung bis zum Beginn des 20. Jahrhunderts*. Neustadt an der Aisch: Verlag Degener & Co., 1966.

Remmert, Volker. *Ariadnefäden im Wissenschaftslabyrinth*. Bern: Peter Lang, 1998.

———. "Im Zeichen des Konsenses. Bibelexegese und mathematische Wissenschaften in der Gesellschaft Jesu um 1600". *Zeitschrift für Historische Forschung* 33, no. 1 (2006): pp. 33–66.

———. *Picturing the Scientific Revolution*. Philadelphia: Saint Joseph's University Press, 2011.

Renn, Jürgen, Dirk Wintergrün, Robert Lalli, Manfred Laubichler, and Matteo Valleriani. "Netzwerke als Wissensspeicher". In *Die Zukunft der Wissensspeicher : Forschen, Sammeln und Vermitteln im 21. Jahrhundert*, edited by Jürgen Mittelstraß and Ulrich Rüdiger, pp. 35–79. Konstanz: UVK, 2016.

Rocher, Philippe. *Le goût de l'excellence : Quatre siècles d'éducation jésuite en France*. Paris: Beauchesne, 2011.

Romano, Antonella. "Teaching Mathematics in Jesuit Schools: Programs, Course Content, and Classroom Practices". In *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, edited by John O'Malley, pp. 355–370. Toronto: University of Toronto Press, 2006.

Rosso, Antonio Sisto. *Apostolic legations to China of the eighteenth century*. South Pasadena: P.D. / I. Perkins, 1948.

Rostorowski, Emanuel. "Ilu było w Rzeczypospolitej obywateli szlachty?" *Kwartalnik historyczny*, nos. 94/3 (1987): pp. 3–40.

Rule, Paul A. *Kung-tzu or Confucius? : The Jesuit interpretation of Confucianism*. Sidney: Allen & Unwin, 1986.

Sahle, Patrick. "Digital Humanities? Gibt's doch gar nicht!" In *Grenzen und Möglichkeiten der Digital Humanities*, edited by Constanze Baum and Thomas Stäcker. Sonderband der Zeitschrift für digitale Geisteswissenschaften, 1. 2015.

Samsonowicz, Henryk. "Polish politics and society under the Jagiellonian monarchy". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 52–69. Cambridge: Cambridge University Press, 1982.

Sander, Christoph. "Medical Topics in the *De anima* Commentary of Coimbra (1598) and the Jesuits' Attitude towards Medicine in Education and Natural Philosophy". *Early Science and Medicine* 19 (2014): pp. 76–101.

Scaglione, Aldo. *The liberal arts and the Jesuit college system*. Amsterdam: John Benjamins Publishing Company, 1986.

Schiebinger, Londa. "Women of Natural Knowledge". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 192–205. Cambridge: Cambridge University Press, 2006.

Schlafly, Jr, Daniel L. "The Post-Suppression Society of Jesus in the United States and Russia: Two Unlikely Settings". In *The Jesuits II : Cultures, Sciences, and the Arts 1540–1773*, edited by John O'Malley, pp. 772–784. Toronto: University of Toronto Press, 2006.

Schorn-Schütte, Luise. *Geschichte Europas in der Frühen Neuzeit : Studienhandbuch 1500–1789*. 2., aktualisierte Auflage. Paderborn: Ferdinand Schöningh, 2013.

Schöttler, Tobias. "From Causes to Relations: The Emergence of a Non-Aristotelian Concept of Geometrical Proof out of the Quaestio de Certitudine Mathematicarum". *Society and Politics* 6, no. 2 (12) (2012): pp. 26–42.

Schuppener, Georg. *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*. Leipzig: Leipziger Universitätsverlag, 1999.

Schuppener, Georg, and Karel Mačak. *Prager Jesuiten-Mathematik von 1600–1740*. Leipzig: Leipziger Universitätsverlag, 2002.

Schwemmer, Oswald. "causa". In *Enzyklopädie Philosophie und Wissenschaftstheorie*, edited by Jürgen Mittelstraß, vol. 2, p. 32. Stuttgart: Verlag J. B. Metzler, 2005.

Scott, Hamish. "Introduction: 'Early Modern Europe' and the Idea of Early Modernity". In *The Oxford Handbook of Early Modern European History, 1350–1750*, edited by Hamish Scott, vol. 1, pp. 1–33. Oxford: Oxford University Press, 2015.

Serjeantson, R. W. "Proof and Persuasion". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 132–175. Cambridge: Cambridge University Press, 2006.

Sewell, David. "It's For Sale, So It Must Be Finished: Digital Projects in the Scholarly Publishing World". *DHQ: Digital Humanities Quarterly* 3, no. 2 (2009).

Shapin, Steven. "'A Scholar and a Gentleman': The Problematic Identity of the Scientific Practitioner in Early Modern England". *History of Science* 29, no. 3 (1991): pp. 279–327.

———. "The Man of Science". In *The Cambridge History of Science*, edited by Katherine Park and Lorraine Daston, vol. 3, pp. 179–191. Cambridge: Cambridge University Press, 2006.

———. *The Scientific Life : A Moral History Of A Late Modern Vocation*. Chicago: The University of Chicago Press, 2008.

———. *The Scientific Revolution*. The University of Chicago Press, 1996.

Shore, Paul. "Enduring the Deluge : Hungarian Jesuit Astronomers from Suppression to Restoration". In *Jesuit Survival and Restoration : A Global History, 1773–1900*, edited by Robert A. Maryks and Jonathan Wright, pp. 148–161. Leiden: Brill, 2015.

———. "Ex-Jesuits in the East Habsburg Lands, Silesia and Poland". In *The Jesuit Suppression in Global Context : Causes, Events, and Consequences*, edited by Jeffrey D. Burson and Jonathan Wright, pp. 229–247. Cambridge University Press, 2015.

Siebert, Harald. "Kircher and His Critics: Censorial Practice and Pragmatic Disregard in the Society of Jesus". In *Athanasius Kircher: the last man who knew everything*, edited by Paula Findlen, pp. 105–132. New York: Routledge, 2004.

Silveira, Luís Espinha da. "Geographic Information Systems and Historical Research: An Appraisal". *International Journal of Humanities and Arts Computing* 8, no. 1 (2014): pp. 28–45.

Smolarski, Dennis C. "The Jesuit Ratio Studiorum, Christopher Clavius, and the Study of Mathematical Sciences in Universities". *Science in Context* 15, no. 3 (2002): pp. 447–457.

Sokoll, Thomas. "Beruf". In *Enzyklopädie der Neuzeit*, edited by Friedrich Jaeger, vol. 2, pp. 43–50. Stuttgart: Wissenschaftliche Buchgesellschaft, 2005.

Söllner, Konstanze, and Bernhard Mittermaier, eds. *Praxishandbuch Open Access*. De Gruyter Saur, 2017.

Sommervogel, Carlos, et al., eds. *Bibliothèque de la Compagnie de Jésus*. XII vols. Louvain: Éditions de la Bibliothèque S.J. : Collège Philosophique et Théologique, Reprint 1960 [1890–1932].

Stasiewicz-Jasiukowa, Irena, ed. *Wkład jezuitów do nauki i kultury w Rzeczypospolitej Obojga Narodów i pod zaborami*. Kraków: Wydawnictwo WAM, 2004.

Steinhauer, Eric. "Recht". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 345–352. Stuttgart: J.B. Metzler, 2017.

Steinle, Friedrich. "Naturwissenschaft". In *Enzyklopädie der Neuzeit Online*, edited by Friedrich Jaeger. Brill Online, 2016. First appeared online in 2014.

Stolarski, P. T. "Dominican-Jesuit Rivalry and the Politics of Catholic Renewal in Poland 1564–1648". *Journal of Ecclesiastical History* 62, no. 2 (2011): pp. 255–272.

Stone, Daniel. *The Polish-Lithuanian State, 1386–1795*. Seattle: University of Washington Press, 2001.

Taylor, Larissa Juliet. *Heresy and Orthodoxy in Sixteenth-Century Paris : François Le Picart and the Beginning of the Catholic Reformation*. Leiden: Brill, 1999.

Tazbir, Janusz. "Hieronim Zahorowski : Zapomniany autor głośnego pamfletu". *Kwartalnik historyczny* LXX, no. 2 (1963): pp. 341–361.

———. *Literatura antyjezuicka w Polsce 1578–1625 : Antologia*. Warszawa: Ludowa Spółdzielnia Wydawnicza, 1963.

———. "Literatura antyjezuicka w Polsce". In *Jezuici a kultura polska. Materiały sympozjum z okazji Jubileuszu 500-lecia urodzin Ignacego Loyoli (1491–1991) i 450-lecia powstania Towarzystwa Jezusowego (1540–1990), Kraków, 15–17 lutego 1991 r.* Edited by Ludwik Grzebień and Stanisław Obirek, pp. 311–333. Kraków: Wydawnictwo WAM, 1993.

———. "The fate of Polish Protestantism in the seventeenth century". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 201–217. Cambridge: Cambridge University Press, 1982.

Thaller, Manfred. "Geschichte der Digital Humanities". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 3–12. Stuttgart: J.B. Metzler, 2017.

Thomas, Keith. *The Ends of Life : Roads to Fulfilment in Early Modern England*. Oxford: Oxford University Press, 2009.

Topij-Stempińska, Beata. "Jezuici i Komisja Edukacji Narodowej w polskiej historiografii XX wieku i początkach XXI wieku". In *Komisja Edukacji Narodowej : Kontekst historyczno-pedagogiczny*, edited by Katarzyna Dormus, Bożena Popiołek, Agnieszka Chłosty-Sikoska, and Ryszard Ślęczki, pp. 409–418. Kraków: Wydział Pegagogiczny Uniwersytetu Pedagogicznego im. Komisji Edukacji Narodowej w Krakowie, 2014.

Udías, Agustín. *Jesuit Contribution to Science*. Cham: Springer, 2015.

———. "Jesuit Scientific Tradition and Ignatian Spirituality". *Lo Sguardo – Rivista di filosofia* 3, no. 10 (2012): pp. 207–219.

Urban, Wacław. "Akademia Krakowska w dobie reformacji i wczesnej kontrreformacji (1549–1632)". In *Dzieje Uniwersytetu Jagiellońskiego w latach 1364–1764*, edited by Kazimierz Lepszy, pp. 253–307. Kraków: Państwowe Wydawnictwo Naukowe, 1946.

Valleriani, Matteo. *Galileo Engineer*. Dordrecht: Springer, 2010.

———. "The Tracts on the *Sphere*: Knowledge Restructured Over a Network". In *The Structures of Practical Knowledge*, edited by Matteo Valleriani, pp. 421–473. Springer, 2017.

Vanpaemel, Geert. "Jesuit Mathematicians, Military Architecture and the Transmission of Technical Knowledge". In *The Jesuits of the Low Countries: Identity and Impact (1540–1773)*, edited by Rob Faesen and Leo Kenis, pp. 109–128. Leuven: Peeters, 2012.

———. "Jesuit Science in the Spanish Netherlands". In *Jesuit Science and the Republic of Letters*, edited by Mordechai Feingold, pp. 389–432. Cambridge: The MIT Press, 2003.

Verboven, Koenraad, Myriam Carlier, and Jan Dumolyn. "A Short Manual to the Art of Prosopography : A Handbook". In *Prosopography Approaches and Applications*, edited by K. S. B. Keats-Rohan, pp. 35–69. Prosopographica et Genealogica, 2007.

Vogeler, Georg, and Patrick Sahle. "XML". In *Digital Humanities : Eine Einführung*, edited by Fotis Jannidis, Hubertus Kohle, and Malte Rehbein, pp. 128–146. Stuttgart: J.B. Metzler, 2017.

Volk, Kasper, and Chris Staysniak. "Bringing Jesuit Bibliography into the Twenty-First Century: Boston College's New Sommervogel Online". *Journal of Jesuit Studies* 3, no. 1 (2016): pp. 61–83.

Voß, Jakob, and Mathias Schindler. "BEACON link dump format". July 2014. `http://gbv.github.io/beaconspec/beacon.html`. Accessed 12/01/2016.

Wallnig, Thomas, and Thomas Stockinger. *Die gelehrte Korrespondenz der Brüder Pez : Text, Regesten, Kommentare*. Quelleneditionen des Instituts für Österreichische Geschichtsforschung. Wien: Böhlau Verlag, 2010.

Walter, Peter, and Melanie Wald. "Jesuiten". In *Enzyklopädie der Neuzeit*, edited by Friedrich Jaeger, vol. 6, pp. 8–15. Stuttgart: Wissenschaftliche Buchgesellschaft, 2007.

Weingart, Peter, and Niels Taubert, eds. *Wissenschaftliches Publizieren : Zwischen Digitalisierung, Leistungsmessung, Ökonomisierung und medialer Beobachtung*. Berlin/Boston: De Gruyter Akademie Forschung, 2016.

Wright, Jonathan. "The Suppression and Restoration". In *The Cambridge Companion to the Jesuits*, edited by Thomas Worcester, pp. 263–277. Cambridge: Cambridge University Press, 2008.

Wyczański, Andrzej. "The problem of authority in sixteenth-century Poland: an essay in reinterpretation". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 96–108. Cambridge: Cambridge University Press, 1982.

Wyrobisz, Andrzej. "The arts and social prestige in Poland between the sixteenth and eighteenth centuries". In *A Republic of Nobles : Studies in Polish History to 1864*, edited by J. K. Fedorowicz, pp. 157–178. Cambridge: Cambridge University Press, 1982.

Zamoyski, Adam. "History of Poland in the 16th–18th Centuries". In *Land of the Winged Horsemen : Art in Poland 1572–1764*, edited by Jan K. Ostrowski et al., pp. 27–37. Alexandria, Virginia: Art Services International in association with Yale University Press, 1999.

Ziggelaar, A. "Scheiner, Christoph". In *Diccionario Histórico de la Compañía de Jesús*, edited by Charles O'Neill et al., vol. IV, cols. 3517–3518. Madrid: Universidad Pontifica Comillas, 2001.

Zilsel, Edgar. *The Social Origins of Modern Science*. Edited by Diederick Raven. Dordrecht: Springer Science+Business Media, 2003.

Zinsser, Judith P., ed. *Men, Women, and the Birthing of Modern Science*. DeKalb: Northern Illinois University Press, 2005.

Żygulski, Zdzisław. "The Impact of the Orient on the Culture of Old Poland". In *Land of the Winged Horsemen : Art in Poland 1572–1764*, edited by Jan K. Ostrowski et al., pp. 69–79. Alexandria, Virginia: Art Services International in association with Yale University Press, 1999.

Appendices

Appendix A.

Lists

A.1. List of names based on Carlos Sommervogel's *Bibliothèque de la Compagnie de Jésus*

For practical reasons, the complete list of all names in the Bliard list (see Section 3.5 and Section 3.6) is provided as a CSV file on jesuitscience.net:

`http://jesuitscience.net/files/listOfAllNames.csv`

The file is structured as a table with the column headings being Last name; first name; Excluded; DHCJ; Lisiak; Schuppener. The last and first name columns contain the last and first names for Jesuits on the Bliard list, respectively.

If a Jesuit is not included in the Jesuit Science Network, he is marked with an 'x' in the Excluded column.[1] If he can be found also in the *Diccionario Histórico de la Compañía de Jesús* or the works by Bogdan Lisiak and Georg Schuppener,[2] he is marked with an 'x' in the respective columns.

To verify the authenticity of the file, you can use the following SHA1 checksum:

`22e4ba172f12c3d4c40db54793e7b173b6549267`

A.2. List of data sources

For a complete list of all data sources, see `http://jesuitscience.net/sources/`.

1. See Section 3.6 for more information on the Bliard list and reasons for exclusion.
2. Lisiak, *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*; Schuppener and Mačak, *Prager Jesuiten-Mathematik von 1600–1740*; Schuppener, *Jesuitische Mathematik in Prag im 16. und 17. Jahrhundert (1556–1654)*.

A.3. Sample for the case study

Name	Bliard*	DHCJ	JSN ID
Grzegorz Arakiełowicz	x	x	47
Jan Bohomolec			32
Franciszek Ksawery Bohusz			1007
Wojciech Przecław Bystrzonowski	x		46
Jowin Fryderyk Bystrzycki	x		31
Marcin Bystrzycki	x		45
Stanisław Chyczewski			42
Benedykt Dobszewicz	x	x	44
Andrzej Gawroński			39
Faustyn Grodzicki	x		25
Jan Hermanni	x		43
Ludwik Hoszowski			41
Grzegorz Kniażewicz	x		40
Jan Koc			30
Adam Adamandy Kochański	x	x	37
Oswald Krüger	x	x	36
Stefan Odrowąż Łuskina	x	x	29
Charles Malapert	x		34
Jakub Nakcjanowicz	x		35
Franciszek Narwojsz			33

Name	Bliard*	DHCJ	JSN ID
Szymon Perovius			18
Marcin Poczobut	x	x	11
Józef Rogaliński	x	x	8
Alexandre Pancrace Rostan	x		27
Tomasz Siekierzyński	x		24
Sebastian Alojzy Sierakowski			23
Jan Mikołaj Smogulecki	x		20
Stanisław Solski	x		12
Andrzej Strzecki			10
Wawrzyniec Susliga			9
Jakub Święcius	x		17
Piotr Świtkowski			7
Wojciech Tylkowski	x		6
Bartłomiej Natanael Wąsowski			5
Tomasz Żebrowski	x	x	1

Table A.1.: Names, dates of birth and death, overlaps with Bliard* and the DHCJ, and JSN IDs for the sample based on Bogdan Lisiak's *Jezuici polscy a nauki ścisłe od XVI do XIX wieku: słownik bio-bibliograficzny*.

Appendix B.

Texts from the project website

On the website, the following texts also include links to email addresses and other websites; these are not indicated below.

B.1. Front page

The Jesuit Science Network is a digital prosopography on Jesuit scholars in the early modern sciences, encompassing the period between the foundation of the Society of Jesus in 1540 and the first few decades after its suppression in 1773. It provides free access to an extensive collection of biographical information on early modern Jesuits in the sciences along with their contemporary contacts.

B.2. Footer and imprint

The Jesuit Science Network originated from a research project funded by the DFG (2011–2016) and is located at the Interdisciplinary Centre for Science and Technology Studies at Wuppertal University.

The digital infrastructure of the Jesuit Science Network was provided by the Person Data Repository project at the Berlin-Brandenburg Academy of Sciences and Humanities.

Primary investigator
Dagmar Mrozik
Email

Academic supervisor

Volker Remmert
Wuppertal University
Email

Contact
Dagmar Mrozik
IZWT
Wuppertal University
Gaußstraße 20
42119 Wuppertal
Germany
+49 176 72 88 04 14

B.3. About

The Jesuit Science Network (JSN) is the PhD project of Dagmar Mrozik, realized at the Interdisciplinary Centre for Science and Technology Studies at Wuppertal University under the supervision of Volker Remmert. It originated from a research project funded by the DFG; the digital infrastructure was provided by the Person Data Repository at the Berlin-Brandenburg Academy of Sciences and Humanities.

This page provides introductory information about Jesuit scholars in the early modern sciences and the project itself. For more information, please see the corresponding PhD thesis.

Jesuit activity in the early modern sciences Since its foundation in 1540, the Society of Jesus has been inextricably linked with scholarship. Among the topics that the Jesuits engaged in between the 16th and 19th centuries, we find geometry and military architecture, calendars and astronomical observations, and even botany and practical medical knowledge—all pertaining to what we now call the early modern sciences. A comprehensive list can be found further below.

The Jesuit Science Network As broad as this range is in content, as widely spread over place and time were its practitioners. The JSN was hence devised as the first general overview over Jesuit scholars in the early modern sciences and realized in form of a digital prosopography, i. e. a digital collection of standardized biographical information, with the corresponding website (that you are currently visiting) as its free access point.

The site allows to explore, search, and export the collected information. At the core of the project is the research interest expressed in the four questions after the "who", "what", "where", and "when".

Early modern sciences To make a long story short and summarize the sentiments of several introductions into early modern science, 'early modern science' itself is the modern attempt to find an umbrella term for those various areas of learned activity in the early modern period that can be considered precursors to what is now often condensed to STEM, science, technology, engineering, and mathematics. For the practical realization of the Jesuit prosopography, the JSN relies on a list of subjects given in a 1997 paper by Steven J. Harris:

Pure mathematics	Algebra, functions, series; analytical geometry; arithmetic; integral calculus and analysis; geometry; logarithms; number theory, probabilities
Mixed mathematics	Mechanics; optics (catoptrics, dioptrics); acoustics (harmonies, theory of music and sound); hydraulics, civil and military architecture; mathematical geography (localization, cartography); scientific instruments, physics cabinets
Astronomy	Calendars, almanachs, ephemerides; clocks (dials, horology); spherical astronomy; lunar and solar astronomy (observation and theory); comets (observation and theory); stellar astronomy (observation); planetary astronomy
Natural philosophy	Commentaries of Aristotle; natural philosophy; philosophy of experience; supernatural and occult questions
Natural history	Cosmography; physical, subterranean, and political geography; hydrography; meteorology (observation, instruments); zoology and botany; cabinets of curiosities, collections
Medicine	Health and disease; anatomy, physiology, surgery; experimental medicine
Agriculture and economics	Woods and horticulture; beekeeping; money, measure and weight

Steven Harris' categorization of topics in Jesuit publications in the early modern sciences, 1540–1800.

Please note that this list is not exhaustive.

The sources The main source for the biographical data collected and presented in the JSN is the twelve-volume *Bibliothèque de la Compagnie de Jésus*. The first nine volumes were edited by the French Jesuit Carlos Sommervogel (1834–1883) between 1890 and 1900 and supplemented by three more volumes in 1909 and 1932; the entire series was reprinted in 1960.

A more modern cornerstone of the project is the four-volume *Diccionario Histórico de la Compagñía de Jesús*, a Spanish-speaking historical dictionary on the Society of Jesus edited by Charles O'Neill (1927–2009) et al. in 2001. It contains articles not only on Jesuits, but also places, institutions, and even subjects connected to or treated by Jesuits.

Aside from these two fundamental works, the Jesuit Science Network also makes use of a number of smaller studies, most of them with a geographical focus. For more information, see the complete list of sources.

Collected information For each person in the Jesuit Science Network, the same kind of information is collected from the sources:

Name	**Education**	**Miscellaneous**
Norm name	Date	Relations
Alternate spellings	Place	'True' miscellaneous
VIAF	Subject	
Biographical data	**Career**	
Date and place of birth	Date	
Date and place of death	Place	
Entry in the order	Subject	
Resignation	Occupation	
Expulsion		

Digital infrastructure The digital infrastructure for the Jesuit Science Network was provided by the Person Data Repository at the Berlin-Brandenburg Academy of Sciences and Humanities. An additional intermediary SQL database allows for more efficient data access. The corresponding source code of the project can be found on GitHub and is provided under the MIT license.

Acknowledgments

Thank you—

to Volker Remmert, for guidance, patience, and giving me free reign

to Matteo Valleriani, for the insights

to Thomas Wallnig, for the perspective

to Claudine Hündgen, for knowing what to do

to Arianna Borrelli, Vanessa Cirkel-Bartelt, Philipp Kranz, and Irina Schmiedel, for the fellowship

to Opa and Klaus, for the garden

to Lars Feyerabend, for the adventures and everything else

"…a PhD thesis is seldom really 'finished', but abandoned in a passable state."

—Stephen Roberts