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Como Relacionar Histórias Regionais a Padrões Gerais de História? O caso do ensino de matemática na Westphalia

How to Relate Regional History to General Patterns of History? The case of mathematics teaching in Westphalia

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Resumo

Este estudo aborda como o ensino de matemática foi implementado na Westphalia entre 1800 e 1840. Como a Westphalia era uma das províncias do estado alemão da Prússia, esta é, evidentemente, uma história inteiramente regional. Pela análise das mudanças políticas, religiosas e culturais concretas ocorridas nesse período, o caso se revela como um indicador para as mudanças gerais pelas quais os sistemas educacionais na Europa passaram depois da Revolução Francesa. Levar em conta os sistemas contextuais contribui para esclarecer a variedade de padrões que caracteriza a história da educação matemática. A pesquisa se baseia em amplas investigações realizadas em arquivos de escolas, de municipalidades, de governos provinciais e do ministério da educação da Prússia.

Palavras-Chave: História da Educação Matemática. Prússia. Westfalia. Período Napoleônico. Reformas Curriculares. Algebrização. Papel Cultural da Matemática.

Abstract

This study is concerned with how mathematics teaching became implemented in Westphalia between 1800 and 1840. Since Westphalia was one of the provinces of the German state of Prussia, this is evidently a particular regional history. By analyzing the

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concrete political, religious and cultural changes in this period, the case reveals to be an indicator for the changes which the educational systems in Europe underwent after the French Revolution. Taking into account the contextual systems contributes to unravelling the variety of patterns characterizing the history of mathematics education. The research is based on extensive investigations in archives of schools, municipalities, provincial governments and of the Prussian ministry of education.

Keywords: History of Mathematics Education. Prussia. Westphalia. Napoleonic Period. Curricular Reforms. Algebraization. Cultural Role of Mathematics.

Introduction

Over an extended period of time, I undertook a considerable amount of research about how mathematics teaching became implemented in Westphalia between 1800 and 1840. Actually, after 1815, Westphalia was one of the nine provinces of the Kingdom of Prussia, and Prussia itself was just one of then 39 states, which were considered to be German ones. The study of Westphalia seems therefore merely to constitute a regional case study; so how far can such a regional case bear any more general importance?

Generally speaking, one might rightly assume that what is going on at the general level, has to be reflected at the local and regional level, too. Consequently, in performing regional or local studies we need to be conscious of the developments at the general level, in order to be able to recognize reflections or specific realizations of such developments. On the other hand, developments at the local or regional level might constitute new patterns, which will eventually generalize to a more persistent feature. Thus, in general, there are interactions between the different levels and it is these interactions, which constitute the complexity of historical research. Admittedly, it is possible too, that some local or regional developments remain definitely restricted to that region and express some entirely particular feature, which does not generalize to other regions. This occurs rarely, but also affords the particular attention of the researcher, to elaborate clearly that specificity. Even such isolated cases may obtain a certain importance.

Regarding overall developments in mathematics education in the period 1800 to 1840, some key moments immediately come into one's mind: on the

one hand, the French Revolution and, in its aftermath, the first establishment of a public education system and – at the same time – the introduction of mathematics as a major subject in the secondary schools. And, as regards mathematics, intimately linked to this profound restructuration, a dominance of the so-called analytic method, of algebraization. On the other hand, there is an evident political and social dimension of these structural changes in many European countries: most countries became a part of the French, Napoleonic system, either as parts of the Empire itself, or as an allied or a satellite state. In varying degrees however, they shared the same social and educational policy during the Napoleonic period, but also the reactionary policy of restoration thereafter. Moreover, one might wonder how the traditional split between the catholic and the protestant education system and the consequent differences in their mathematical curricula might be affected by all these changes.

Given these general trends of history, what's about Westphalia and its mathematics teaching in particular? Actually, before 1815, Westphalia had not existed as a political unit. By 1815, it was an artificial creation, and one issue of its creation was whether it would gain sufficient coherence and, in particular, a common educational structure for its new citizens. It was hence of a key importance whether the *Gymnasien* in this new province would be able to function according to a common structure and conception.

The outset

As a result of the Thirty-Years War, the political landscape in the region of Westphalia represented, as in other regions, a patchwork of numerous sovereign entities – principalities, dukedoms, counties, components of kingdoms, clerical states, independent towns, etc. Without counting even smaller entities, it consisted of 28 "states" within the realm of the Westphalian territory. Besides all its disparities, some structural features can be identified: as another major result of this same war, a first form of a total war and which had traumatized population and governments, there was a certain form of religious tolerance – with the consequence of a peaceful coexistence of states with a catholic religion and others with a protestant one. And several greater states

were "owners" of dependencies in Westphalia: on the one hand, the electorate of Cologne, a politically very important and influential clerical (and hence: catholic) state, governed also the dukedom *Westfalen* (capital Arnsberg) and the *Vest Recklinghausen*, the region around Recklinghausen. There were two other considerable clerical states, the archbishoprics of *Paderborn* and of *Münster*. While one used to elect in Paderborn a catholic elector from some other region as governor, one practiced a more independent policy in Münster. As a clerical state, there was, moreover, the strange form of the archbishopric of *Osnabrück*: there, a catholic bishop used to alternate with a protestant one.

On the other hand, Prussia –a protestant state originally located exclusively in the east of the German Empire, but expanding more and more – had established some footholds in the West, namely the principality of *Minden-Ravensberg* and the county *Mark*.

What was the situation of mathematics education in this region until 1789? Here, the religious split between the catholic and protestant faith was constitutive for the divergent educational systems, and mathematics was decisively affected by their differences. I have presented these differences already elsewhere (SCHUBRING, 2002) so that I will restrict myself to an outline. Since Luther's Reformation, a system of secondary schools, *Gelehrtenschulen* or *Gymnasien*, had in particular expanded their preparation for studies at universities where their Philosophical faculties would at first deepen propedeutic knowledge, including mathematics, before students went on to professional studies. The focus of teaching at the secondary schools was on classical languages. Mathematics was for a long time, despite Melanchthon's more wide-ranging conception, restricted to reckoning and arithmetic in the lower grades. Only during the eighteenth century, did this become gradually supplemented by geometry teaching in the upper grades.

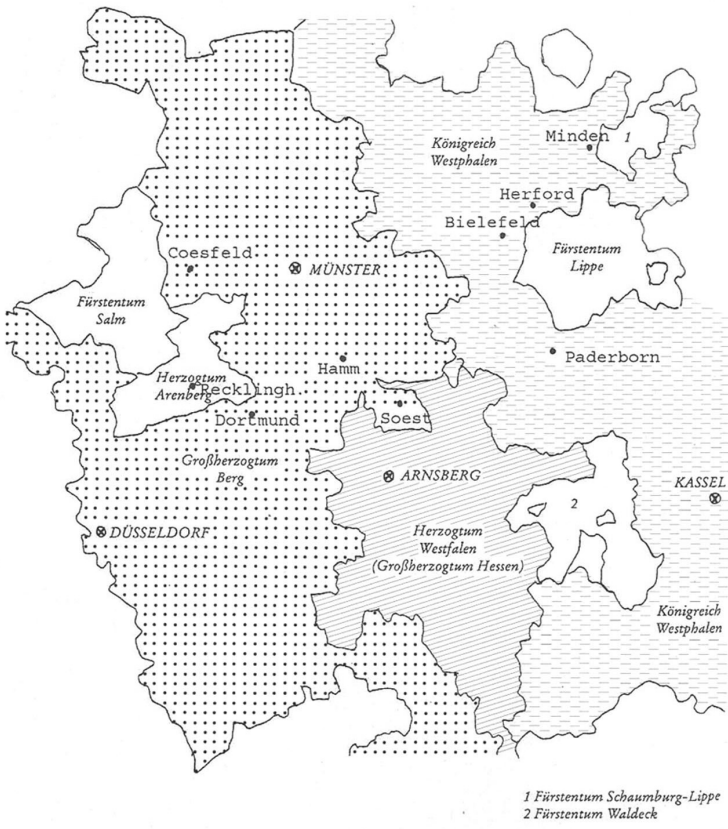
In the catholic territories, the education system was dominated by the Jesuits and by their *Ratio Studiorum*, which defined in a uniform manner the structure and the contents of teaching. The teaching of the former faculties of arts had been supplanted by the new colleges, which copied the model of *Gymnasien*, but radicalized the monopoly of language teaching: in each grade, the teaching of just one subject was permitted – their psychology thought it

harmful for the intellect to be occupied by more than one subject at a time. Only in the last grade, the philosophical classes – extending, contrary to the preceding grades, over two, respectively three years – the teaching of philosophy had subdivisions, according to the Jesuit vision of Aristotle's philosophy: in particular ethics and physics. And as a part of physics, a few months of mathematics teaching were prescribed, of a very elementary level, due to the missing earlier teaching.

While the expulsion (from 1759 on) and dissolution (in 1772/3) of the Jesuit order prompted the majority of catholic states to undertake educational reforms, without lasting effects, in general, due to the still unchanged feudal structures of society, there was one state (of medium size, according to German standards) which had already earlier initiated profound reforms independently of the overall anti-Jesuit policy, due to the Enlightenment. This was the clerical archbishopric *Fürstbistum Münster* where the enlightened governor Franz von Fürstenberg had effected structural and curricular reforms since 1763. Regarding the college/Gymnasium, he replaced the former monopolist curriculum by a multiple-subject one, introducing for the first time mathematics as one of the major teaching subjects, to be taught in each grade. Its rationale was the function ascribed to it to promote logical thinking, and not a utilitarian one. It was Fürstenberg himself who trained the first mathematics teacher to realize the new curriculum. This teacher, Caspar Zumkley, even became the director of the highly renowned *Gymnasium* in Münster. And, he turned out to be a prolific author of the mathematics textbooks for this new function. The new curriculum also became applied to the other secondary schools in the *Fürstbistum* and served as a model for the territories in Westphalia governed by Cologne, but the conditions were missing there to apply it entirely.

Chances for more general changes in the educational system were given by political events in the aftermath of the French Revolution: due to pressures by Napoleon, the formally still existing German Empire undertook a major reform in 1802/03. By the so-called *Reichsdeputationshauptschluß*, all clerical states were dissolved and their territories handed over to the greater secular states. This implied major changes on the landscape of Westphalia, evidently, since its majority had been occupied by clerical states. The greatest

share was received by Prussia, who now not only succeeded in uniting its formerly separated components *Mark* and *Minden-Ravensberg* by acquiring *Münster*, but also gained *Paderborn* – thus integrating considerably extended catholic territories. While Prussia intended to reform the educational systems in the newly acquired regions in its enlightenment-minded manner, it was not able to change much, since its catastrophic defeat in 1806 in its war against the French Empire made it loose all its territories in the West. Another winner was a state, not yet represented in this region: the county of *Hessen-Darmstadt* who expanded considerably to the North, incorporating the former *Herzogtum Westfalen*.



Political map of Westphalia in 1808 (KLUETING, 1998). The towns indicated by points are those with a later Prussian Gymnasium, the other names are capitals of the states.

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The French period

Napoleon used the Prussian defeat for a major territorial restructuring. In 1806, he had already established the *Rheinbund*, a loose confederation of numerous German states adhering more or less voluntarily to the guidelines of French policy. Among them was *Hessen*. Moreover, he now created two satellite states in Germany: the Kingdom of Westphalia (capital: Kassel) and the Grand Duchy *Berg* (capital: Düsseldorf), both governed by his relatives. Hence, the region of Westphalia was divided among three powers: two direct satellite states of the Napoleonic Empire (Großherzogtum Berg and Königreich Westfalen) and one genuine German state allied to France - now called Großherzogtum Hessen (see the map). Given the strong position of mathematics in the *lycées* established in France since 1803 (SCHUBRING, 1984), we should therefore expect an immediate and marked reinforcement of mathematics in secondary schooling. In 1810, Napoleon dared to occupy and annex parts of the territories governed by his relatives, together with large parts of Northern Germany, directly to the French Empire, so that – for instance – the northern parts of *Minden-Ravensberg* and of *Münster* became French (see BERDING, 1973). Since a key characteristic of French educational policy in the Napoleonic period had been its strict uniformity for the entire country, and since satellite and allied states used to copy more or less the French structures, one should hence expect now a new status for mathematics teaching.

The surprising result of my research was, however, that this was not the case. The governments in Düsseldorf and in Kassel began only after several years to plan educational reforms, but they missed the necessary conceptions as well as energy to realize any essential changes. An explanation is, that these satellite states were victims of the financial burdens by which they had to contribute to finance Napoleon's permanent wars, so that the governments could not spend on educational reforms. Even in the northern parts, which were French from 1810 on, projects for assimilating them to the common structures in the French departments did not become realized until 1813/14 when this entire system collapsed. The only state reorganizing somewhat the schools within its new territories was the originally German one: *Hessen*. During

its government, mathematics teaching became in fact reinforced in Arnsberg, the only Gymnasium in that region.

We have to state here the revealing paradox that states, which were projected as model states of modern Napoleonic social and cultural structures for Germany as a whole, were not able to reform accordingly the educational system and in particular to promote mathematics teaching, one of the core components of the French original.[2]

Becoming a Prussian Province

After the collapse of the Napoleonic system, an international congress of the allied powers, held in Vienna in 1815, decided about the new political landscape in Europe. In general, Napoleon's allies were the losers and his enemies were the winners. Thus, *Hessen* lost its gains in Westphalia and was reduced to the former dukedom Hessen-Darmstadt. Prussia, on the other hand, was one of the global winners; and with regard to Westphalia, it now obtained all the Westphalian territories – much more than the status quo of 1803 (see map). Moreover, Prussia obtained the new Rhine Provinces (ex-Cologne) and thus constituted one of the major powers in Germany. By now, Prussia consisted of nine provinces and faced in particular the problem of establishing a common state for Protestants and Catholics, who used to live hitherto in more or less mono-religious states with decidedly different cultural and social systems. This problem was particularly acute in Westphalia, which united numerous formerly independent states of either catholic or protestant character – and the latter were even divided into Lutheran and Reformed (Calvinist) directions. Münster became capital of the new province. After the first reorganizations by the Prussian government, there were eleven *Gymnasien*, which survived or were upgraded from a minor status: five were catholic ones and six were protestant ones. The five were the *Gymnasien* in Arnsberg, Coesfeld, Münster, Paderborn, and Recklinghausen and the six were those in Bielefeld, Dortmund, Hamm, Herford, Minden, and Soest (HERMANN, 1991).

[2] In other respects, they succeeded, however, in implanting lasting social and political reforms, for instance by the introduction of the *Code Napoleon*, as the legal code.

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The constellation for the by now inevitable and urgent educational reforms in Westphalia was rather unique. As is well known, as a consequence of its catastrophic defeat in 1806, Prussia had thereafter undertaken a profound overhaul of its entire political, social and educational structures – at first in the territories that remained Prussian after Napoleon's dictate of a peace treaty. Famous are the decisive reductions of feudal structures, like the liberation of the peasants, and the educational reforms, linked to the name of Wilhelm von Humboldt who directed the key period of these reforms in 1809/10. The conceptually – and practically – most difficult issue of these reforms was the dialectic between the centrality of government policy and the initiatives and implementation at the basis. In fact, the key conception of all these reforms was *Selbsttätigkeit* – one's own activity: on the one hand, the reforms should not just be decreed from above, they should be embraced and enacted by proper initiatives and activities by the citizens themselves. On the other hand, there should be a convergence between local and central intentions – actually, not at all trivial to be achieved!

The reform conceptions as conceived of at the top for the educational system as a whole and for mathematics in particular were in fact quite revolutionary. Regarding the curriculum of the *Gymnasien*, it should realize the neo-humanist view of *Allgemeinbildung*, of general education, i.e., to incite and develop all the intellectual capacities – before training them for definite professions. Therefore, three major teaching subject areas should constitute the core of instruction in each grade: classical languages, history and geography, mathematics and the sciences. To realize this, each Gymnasium should have at least two teachers for each of these subjects: an *Oberlehrer* and an *Unterlehrer* – for the upper and for the lower grades. Correspondingly, the Philosophical Faculties of the universities were restructured to provide the scientific training of these teachers.

Regarding the curriculum, experts elaborated a comprehensive and coherent program in 1810, operationalizing this concept of neohumanist *Allgemeinbildung*, which was integrated as so-called Süvern-Lehrplan into the projected law for the reformed school system. Johann Wilhelm Süvern was the responsible official in the ministry for the projected law; the part for

mathematics was elaborated by Johann Georg Tralles (1763-1822), member of the Berlin Academy and first professor of mathematics at the newly established Berlin University. The projected law was never enacted – yet, not because it would have contradicted the principle of *Selbsttätigkeit* (a legal structure and frame were necessary), but due to conservative resistance within the government. The part about the *Gymnasien* became therefore communicated by the ministry to the regional authorities as a "Richtschnur" – guiding principle – in 1815 (SCHUBRING, 1991, p. 45).

The program for mathematics was absolutely novel and ambitious: Planned for the six grades of the Gymnasium, covering nine years of secondary schooling and for six weekly hours in each grade, its rationale was an algebraic vision of mathematics. Sure, there was extended instruction in geometry, beginning with elementary constructions. It proceeded to angular functions and ended with analytical geometry in two and three dimensions and especially with conic sections. Geometry was complemented by an even more extended program in arithmetic and in algebra: the four basic operations were immediately followed by the reflection of the decimal system and the introduction of decimal fractions. This was followed by the generalization to non-decimal number systems. The programme continued with elements of algebra, theory of equations – from the first degree up to the fourth; binomial theorem, logarithms, combinatorial theory; and developed over the last four years the elements of the differential and integral calculus: elements of the theory of series, arithmetical series, the Taylor theorem and developments into series; eventually, probability and applied mathematics (*ibid.*, p. 44).

Beginning Reforms in the Westphalian Gymnasia

Compared with these ambitious curricula and with the endowments necessary for such well organized and well paid staffs of teachers, the state of the schools in Westphalia was, in general, terribly poor. It needed enormous investments for the governments to establish better and larger buildings, to increase salaries and create new positions for teachers and eventually, to achieve curricular reforms. This was the more complicated as a number of the Gymnasia

were financed by the municipalities. Each town was eager to have a Gymnasium within its walls, but the majors and the councillors were always reluctant to increase the budget and the salaries; they were notorious for economizing particularly in the school sector. There was an expedient: the state could endow a new position for a teacher or contribute to increase the general budget. Yet, this implied the right for the state to participate in the administration of that school – in particular, to have the right to select and contract the teacher for such endowed positions; and not all municipalities welcomed such concurrence of the state (see HERMANN, 1991).

With regard to mathematics, by 1815, only one protestant Gymnasium provided regular and extended mathematics teaching (Dortmund) and had a teacher for this instruction; for the catholic Gymnasia there were two (Münster, Paderborn).

To understand school policy in Prussia, it needs to be emphasized that there were three levels of administration and responsibility: the central one with the ministry of education ("Kultusministerium") in Berlin, the provincial one with the *Provinzialschulkollegium* in the capital of each province and there as key acting person(s) one or two *Provinzialschulrat* (provincial school administrator), and the local one: on the one hand the directorship of the Gymnasium and on the other hand the municipality since a considerable part of the Gymnasia were not state-owned, but run by the municipality.

Right at the beginning of the concrete process of reforming the Westphalian Gymnasia, the 6 November 1817, the Berlin ministry communicated the Süvern-Plan to the *Konsistorium* in Münster – a mixed institution by state and church to administrate school and church affairs, but supplanted in 1818 by the *Provinzialschulkollegien*, essentially exclusively state authorities. The Süvern-Plan should serve as a guideline for establishing the new system of secondary education in the province of Westphalia (SCHUBRING, 1991, p. 54 and p. 227). In fact, it was used the next year to criticize the curriculum as proposed by the Gymnasium in Hamm for not giving mathematics the necessary equality in rank with Latin or Greek (*ibid.*, p. 55).

In general, one can remark that there existed an overall consensus at all the levels of administration and policy – central, regional, and local – with

regard to the high rank of mathematics as one of the three major components of secondary schooling. The key prerequisite for implementing this decidedly novel role of mathematics was hence fulfilled. Nowhere in Westphalia within these first decades did a resistance show up against mathematics.

Since the regional level was the one which had to mediate between initiatives and conceptions at the level of the ministry and possible resistance at the local level, it was quite decisive how the persons there would handle the matters of reforming and consolidating. At first, the ministry had relied on local staff from Münster, mainly from the Gymnasium there. They proved to be not as active as necessary, being too much tied to their local context. Therefore, from 1818 on, the ministry called persons from outside to act as *Provinzialschulrat*. The first one is well known as an educator: Friedrich Kohlrausch. It was his task to urge everywhere for increasing the budgets – the municipalities as well as the ministry – and to care for complete staffs of teachers, including the mathematics teachers.

It was he who had the idea to inaugurate a means, which should prove to constitute an excellent procedure for reducing the enormous heterogeneity among the Westphalian Gymnasia and achieving a common understanding and a more homogeneous functioning of these schools: the *Direktoren-Konferenzen* – the meetings of the directors of the Gymnasia. At these meetings, all issues of common interest for the schools were discussed and one tried, moderated by the *Schulrat*, to achieve a consensus. Particularly productive were the discussions about the teaching of the various subjects – this the more as there existed no common syllabus, due on the one hand to the missing general instruction and law and on the other hand to the conception of *Selbsttätigkeit*; thus, each Gymnasium defined its own syllabus; its control by the *Provinzialschulkollegium* was not too strict. The first such meeting took place in 1823 and became a regular meeting, to be held every two or three years. They proved to be such a productive means for the inner reform of schools that they were soon also copied by the other Prussian provinces.

In 1830, Kohlrausch (who had changed to the Kingdom of Hanover), was replaced by the protestant Christian Friedrich Wagner (1782-1863). Actually, Wagner was an extraordinary personality. He was not only an

experienced mathematics teacher, he was also a first exponent of the neo-humanist program. Originating from West-Prussia, he had studied at Königsberg University and acted as a teacher at renowned schools. In 1810, he was the first to be examined according to the new neo-humanist regulations and it was Wilhelm von Humboldt himself who approved the result and his call to the position of *Oberlehrer* for mathematics in Gumbinnen in East-Prussia. In 1815, he published a paper on the classical issue of curvilinear angles. In 1816, Wagner changed to the position of *Schulrat* within the regional government of Gumbinnen (SCHUBRING, 2010).

Since the financial basis of the Westphalian Gymnasia and their equipment with adequately paid teacher positions was decidedly improved by then, Wagner concentrated on inner reform. While Kohlrausch had restricted visitations of schools to the occasion of particular inaugurations, Wagner made visitations to a regular practice more or less each year. And his particular focus during his visitation of each Gymnasium was on the mathematics lessons and his talks with the mathematics teachers. The advice for content and method of teaching he gave in these discussions and in his reports show him as a moderately modern practitioner.

Remarkable is his focus on pedagogical methodology, on the application of modern developments in the wake of Pestalozzi; regarding contents, he was in favour of spherical trigonometry and conic sections – the two topics later on excluded by the ministry considered to be no more subjects of school mathematics -, but there were never signs that he accepted more algebraic or even analytic topics.

The two competing programs and the controversies in the Westphalian Gymnasia

What makes Westphalia to a particularly telling case for the process of implementation of the neo-humanist reforms was an unprecedented action prepared by Wagner in 1833. That same year, in the province of Saxony, an anti-mathematical movement had exploded for the first time. That province, established in 1815 by the incorporation of territories of the Kingdom of Saxony,

an earlier ally of Napoleon, still knew strong defenders of the earlier exclusively classical curriculum of the royal Saxon elite schools. The 1833 meeting of the Saxon directors turned into a rebellion against the neo-humanist role of mathematics. The Saxon *Provinzialschulrat*, J. A. Matthias (1761-1837), himself a devoted mathematics teacher and author of influential textbooks, but somewhat impeded by his age, had problems to withstand this rebellion (SCHUBRING, 2001).

Wagner had therefore the idea to consolidate the state of mathematics teaching already achieved in Westphalia by elaborating a common syllabus for the Gymnasia. This does not seem to be extraordinary; in fact, the point was another one: he asked two mathematics teachers whom he assumed to represent different visions of good mathematics instruction to elaborate each one a proper *Lehrplan*. Having received the two proposals, which were in fact quite antagonistic, Wagner submitted both texts to the staff of the eleven Gymnasia, asking for a common deliberation of the respective advantages and disadvantages. Historically, it is – to my knowledge – absolutely unique not only to have two competing programs but also to have them discussed in all schools concerned! And, even more unique, the discussion was not restricted to the mathematics teachers and/or the directors, but comprised, in general, the entire staff. All these discussions are well documented and extant, as well as the subsequent final discussions in the *Direktoren-Versammlung* of June 1834.

The actors of 1834

The two protagonists were Adolph Tellkampf (1798-1869) and Ludwig Erhard Suffrian (1805-1876); actually, both were protestant. Tellkampf, originating from Hanover, had begun a military career very early, during the anti-Napoleonic wars, but had then studied mathematics at one of the best universities, Göttingen, and achieved there not only the doctoral degree, but also the degree of *Privatdozent* so that an academic career seemed to be open to him. Severe health problems forced him, however, to resign and he was happy, after recovering, to obtain the position of mathematics teacher at a

Prussian Gymnasium, in Hamm in 1824. Before, he had not been a productive mathematician, being a disciple of Bernhard Friedrich Thibaut (1775-1832), a practitioner of rather traditional mathematics. Yet, regarding school mathematics, Tellkampf favoured modern branches of mathematics like descriptive geometry and analytic geometry. His textbook *Vorschule der Mathematik*, published since 1829 in various editions, included the concept of functions and analysis in the sense of the theory of series. Although not adhering entirely to the program of the Süvern-Plan, he preferred its algebraic vision. Not prepared for the teacher's profession, Tellkampf became a successful teacher. In 1835, Tellkampf returned to Hanover where he became the director of a newly created realist secondary school and a major spokesman of German mathematics teachers.

Suffrian represented the opposite pole. Born in Minden, he soon changed to the Prussian province of Saxony. He ended secondary schooling in Halle and studied mathematics and theology there. His favourite subject was astronomy, it was also the subject of his doctoral dissertation. Being a teacher for mathematics and natural sciences from 1825 on, still in the same province, he favoured elementary synthetic geometry and especially mathematics with a flavour of classical antiquity. In 1833, he changed from Saxony to Dortmund where the director was a philologist ardently admiring that classical antiquity. Somewhat parallel to Tellkampf, Suffrian became director of a realist school in Siegen, in 1836, and in 1848 director of the Gymnasium in Minden and, eventually, in 1850, successor of Wagner in Münster.

And who were the other mathematics teachers, active in 1834? A prosopographical analysis shows as a common characteristic that the great majority were young, born between 1800 and 1806 and hence educated according to neo-humanist principles. But otherwise one has to differentiate between catholic and protestant teachers. All the catholic ones originated from Westphalia and returned there after having studied. The two elders were clerics and had not studied at all or had not studied mathematics. The younger ones had studied almost all in Bonn, at the university created in 1818. And for them, a revealing contradiction became characteristic: although this university represented, together with that in Berlin, the new neo-humanist conception,

the ministry had not been able to find for it a modern mathematician and had called Wilhelm Adolph Diesterweg (1782-1835) as professor of mathematics. Diesterweg, a former teacher, was not a productive mathematician; he cultivated ancient Greek mathematics according to the standards of classical philology, in particular reconstructing and editing Apollonius's work on conic sections.

The younger protestant teachers all came from outside Westphalia and had studied at various Prussian universities so that they followed different visions of school mathematics and were not as homogeneous as their catholic colleagues.

A prosopographical study of the directors shows similar patterns. All the catholic directors originated from Westphalia; the three elder ones were clerics – only one of them had studied at a university. The two younger ones had studied according to the neo-humanist visions and had an active own interest in the natural sciences. Among the protestant directors, only one had been educated in Westphalia. The two elders had studied encyclopaedically and were both active as mathematics teachers, too. The four younger ones were specialized in philology, but showed no hostility or indifference regarding mathematics.

The protestant regions in Westphalia had not cultivated enough mathematics in the pre-reform-period to already provide "home-grown" mathematics teachers. While only one teacher – Tellkampf – had studied mathematics sufficiently to follow its modern developments, the overwhelming majority is characterized by a rather traditional view of mathematics, by an attachment to elementary mathematics. This had the precious advantage however, to be well integrated into a common understanding and discourse with the colleagues of other disciplines in the staff of their Gymnasium.

The differences in the two syllabi

There were two key issues, which determined the emphasis of the two documents and of the ensuing debates: the *Bildungswert* – educational value – of mathematics instruction and the relation between arithmetic/algebra and geometry within school mathematics.

According to the classical educational discourse, the *Bildungswert* of a school discipline had to be legitimated and specified between two poles: the material and the formal one – i.e., a utilitarian function and its capacities to contribute to the formation of logical thinking.

Suffrian's plan strictly separated an exclusively material value in the two lower grades – Sexta and Quinta -, focussing on practical abilities in reckoning, and formal value in the middle and upper grades. Opposing strictly geometry and arithmetic/algebra, he ascribed geometry the decisive educational importance. Mathematics teaching in the middle grades should begin with geometry, based on a modern adaptation of Euclid, and form the student "to a capable geometer in the manner of the Ancients". All interference with arithmetic and the notion of number quantities should be postponed as long as possible and in any case take place only in the upper grades. There, he admitted the binomial theorem, logarithms, series and applications of algebra to geometry to be taught – and even to complete the hitherto exclusively synthetic geometry by "geometry according to the methodology of the moderns", i.e. the use of analytic methods for conic sections. The neatest expression of Suffrian's views should at the same time constitute the climax of mathematics instruction: in the upper grades, to read Euclid in the Greek original!

Tellkampf, on the other hand, differentiated between the *Bildungswert* of arithmetic and geometry, too, but not as extremely as Suffrian. For him, arithmetic constituted but seldom the source for immediate insight, whereas geometry allowed intuitive access, since the object of consideration lies in the consciousness of the student. As an educational means, geometry outweighs arithmetic. In a certain sense, this claim of superiority for geometry remained restricted to educational rhetoric – the details of his syllabus show a well-balanced programme. The two lower grades were not as sharply separated from the following ones: instruction there should prepare the later "strictly scientific teaching" by understanding the basic concepts of arithmetic and by sensual intuition of spatial forms. Prime numbers and proportions were included here. Arithmetic and algebra constituted a considerable part of the "scientific" instruction in the middle and upper grades. In conformity with the Süvern-Plan, non-decimal number systems should be studied: to make the principles

of the usual decimal system fully conscious. Topics here included the binomial theorem, the combinatorial theory, the elements of higher number theory and the solution of indeterminate equations. Contrary to his textbook, the notion of function should not be treated (except for the trigonometric functions – but within geometry); likewise, he criticized the introduction of the calculus as practiced by some mathematics teachers in other provinces. Regarding geometry, plane and spherical trigonometry were evident as well as conic sections, treated synthetically and analytically. New was his proposal to adapt Carnot's *géométrie de position*.

Both plans, each one comprising in the original print twelve large pages in a small font, are – to my knowledge - the earliest detailed syllabi for mathematics instruction at secondary schools. Both consist of a general part with methodological reflections and recommendations and a special part with extensive presentation of the concepts to be taught in each case and indication how to link these concepts to have a linear, ascending sequence. It is not possible to present here more of this richness.

The debates in the eleven Gymnasia

The two controversial concepts instigated intense debates within the staffs of the eleven schools. The general focus was again on the *Bildungswert* and on the relation between arithmetic and geometry. Moreover, the mathematics teachers contributed extensively to the especially didactic issues of sequencing the various concepts and their suitability. None controversy or divergence about the place and legitimacy of mathematics instruction showed up, however; the general atmosphere was entirely non-controversial.

Suffrian's radical separation of the instruction in the lower grades from the higher ones and its restriction to utilitarian practicing of the four operations was almost generally rejected. Also in these grades, instruction should have a "formal" component. And several schools - remarkably, largely catholic ones – also argued for teaching geometry in the lower grades.

Likewise, Suffrian's radicalism in almost excluding arithmetic and algebra from being taught and reducing mathematics rather to geometry

remained isolated. Teachers and directors argued for a more balanced relation between these two key branches. Likewise, the proposal to read Euclid in Greek was almost everywhere rejected – with but two exceptions: characteristically in schools where there were no ambitions to include advanced topics into the syllabus. The general consensus was to attribute the superior educational value to geometry – due to its alleged predominant function to exercise the mind and to form logical thinking.

Besides these general discussions, considerable extension was given to debates whether the sequencing of topics proposed by the two authors did meet the exigencies for learning as conceived of by the individual teacher and the specific situation at the respective school which continued to be highly differentiated. Actually, no two teachers agreed about these questions of teaching practice! One such issue, for instance, was: should plane trigonometry be taught before stereometry or after it and which of them in *Sekunda* or in *Prima*? An issue of common concern was, however, whether two topics could remain to be admitted within school mathematics: spherical trigonometry and conic sections. On the one hand, all teachers agreed that these topics, which were standard hitherto and which were esteemed as highly important, should be maintained; on the other hand, they were conscious that they did not appear in the list of topics for the final exam, the *Abitur*. Due to the missing general curriculum, these regulations for the *Abitur* of 1812 served, in a rather vaguely defined way, as a substitute. There was just one school where the teachers boldly demanded to extend instruction as far as the elements of the calculus: remarkably enough, it was the Münster Gymnasium, the school in Westphalia with the longest experience in a comprehensive mathematical curriculum.

The meeting of the directors

The meeting of the directors at the end of June 1834 had been well prepared by Wagner. Two of the directors had been charged as reporter and as co-reporter and had studied all the documents and reports from the schools. After their reports, there was an extended and careful discussion, which is also well documented, and this final discussion occurred in a sympathetic

atmosphere, without any divergence about fundamental issues.

The discussion brought no new arguments, but confirmed the consensus which had emerged in the debates within the eleven Gymnasia: instruction in the lower grades should prepare for the later more scientific character of mathematics teaching. Geometry should predominate due to its formative character; its instruction should begin in *Quarta*, the first of the middle grades – one year earlier than arithmetic/algebra. All the details of the discussion about sequencing, methodology etc. were declared to be not capable of a decision from above – thanks to the neo-humanist principle of autonomy of the scientifically trained teacher, such decisions belonged to the realm of his autonomy.

There was one decision, however, which meant a disappointment for the mathematics teachers. Contrary to the opinion expressed almost unanimously, the directors judged spherical trigonometry and conic sections as being not legitimated by the regulations for the *Abitur* and voted therefore to admit to teach these topics only in the case of a particularly capable class. However, this restriction created no conflicts between directors and mathematics teachers, since a central decree by the ministry of December 1834 formally excluded these two topics from school mathematics in Prussia (SCHUBRING, 1991, p. 64).

Aftermath and conclusions

Westphalia proves to be the case of a successful implementation of mathematics as a new major teaching subject in the reformed Gymnasia. On the one hand, in this period, the neo-humanist conception of general education based on three pillars, one of them being mathematics, met a general consensus in society. On the other hand, its practice had been effectively prepared by the Fürstenberg reforms in the clerical state of Münster.

Contrary to the general thesis by Max Weber about the role of Protestantism, it was the catholic territories, that ensured the successful implementation. In the protestant territories, the state of the Gymnasia before 1815 had been too poor to develop a solid basis. This confirms the importance of developments de "long durée" – of long-term.

The curricular development confirms this pattern of long-term-structures: the conception of the arithmetic/algebraic part of the teaching contents which persisted corresponds neatly to what is known since Newton as *Universal Arithmetic*.

Furthermore, one has to state that Prussia presented in the period after 1815 – a period, in Europe generally characterized by conservative restoration, by drawbacks, even by returns to almost Jesuit school structures – one of the rare states where the impetus of inner, social and cultural reforms was maintained. This peculiarity of Prussia has been called its policy of a revolution from above, which prepared Prussia's later economic and political power (see JEISMANN, 1996). Drawbacks were not as dramatic. In fact, the exclusion of conic sections mentioned above did not affect the position of mathematics as a major teaching subject.

One has to be aware that the exclusion of these topics was the price to be paid for the non-conflict-laden integration of mathematics into the conception of general education and its realization in the structure of the Prussian Gymnasium, which prepared students for the universities. It was to a considerable degree due to the elementary, non-specialized character of the syllabus and its allusions to notions familiar to a classically minded and educated social elite that the consensus, which proved to be so operative in the case of Westphalia, had been able to emerge and to be maintained for a considerable period.

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