An Institutional History of Classical Mathematics Teaching in Saxony (1773-1848)

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Abstract

This paper gives an account of the history of mathematics teaching in Saxony from 1773 to 1848, focusing on the second quarter on the nineteenth century. Going through the archives of the Saxon state, it shows that the political influence of many philologists and the independence of secondary schools from the state were the two main obstacles to the reforms. It also describes the quick improvement from 1830 on, due to the creation of a ministry of education. The contributions of many Saxon mathematicians, and above all of Moritz Wilhelm Drobisch, testify to the relationship between secondary and university mathematics. We also show that the impact of reforms in Prussia, Bavaria and other German states has not been insignificant; a close comparison will however highlight many differences between the different systems, so that the path followed by Saxony can be considered as individual, although not entirely autonomous.

Introduction

In Germany, the first half of the nineteenth century saw the professionalization of mathematics, with both teaching and research gradually becoming independent careers. This process has already been studied for several states and especially extensively so for Prussia (Jahnke, 1990 ; Schubring, 1991 ; Schubring, 2012). As the first and biggest German state where a comprehensive reform had been undertaken, it is said to have influenced its neighbors who adopted similar institutional structures, although with delay and sometimes with different conceptions of the discipline (Schubring, 1987, p. 218; Schubring, 2012). In the first half of the

century, however, as F. Paulsen explains, non-Prussian states were "with regard to the history of education a relatively independent area" (Paulsen, 1885, p. 638). We will show that in Saxony, a small state to the south of Prussia, the pace of reform was in fact substantially different not only from Prussia, but also from the other German states. To describe and understand this process, it is necessary to consider the uniqueness of Saxony, which has its own tradition both in mathematics and in secondary teaching. Many factors are to be taken into account if we want to rightly understand the issues of the successive reforms and the content of the mathematical teaching: the influence of the philologists, the central role of the university of Leipzig and its professors, the weakness of the central state and the economic interests of the rising industry.

The main official political decisions concerning the history of mathematics education in Saxony are fairly well known (Paulsen, 1885, pp. 640-651; Schubring, 1991, pp. 30-32, 90-91). The study of the actual application of the successive laws has, however, so far been mainly based on individual reports compiled by historians, describing the situation in various schools and especially the resistance of Latin and Greek teachers against any attempt to introduce mathematics in classical secondary schools (Starke, 1897; Witting, 1910). Until now, neither the archives of the ministry of education nor the proceedings of the Saxon parliament have been extensively studied. When compared with the existing literature, these archives give us new insights into the attitude of the state, especially in the second quarter of the nineteenth century, when most of the decisive reforms are implemented. These records also allow us to account for the evolution of curriculum, teaching methodology and status of the community of mathematics teachers. Given the size of the state, it is also possible to make an exhaustive analysis of the secondary schools concerned, to study to what extent the regulations and laws are implemented.

In the first part we will study the regulation concerning secondary education issued in 1773 (Schulordnung, 1773) and the conditions and content of mathematics teaching in late eighteenth century Saxony. The main issues of the debate between philologists and mathematicians about the role of mathematics and natural sciences in education in the first decades of the nineteenth century will then be highlighted, in order to understand why the *status quo* concerning mathematics lasted until the 1830's. When a ministry for education was created in 1831 a new organization for secondary schools seemed all but inevitable. We will then carefully follow the many contributions of mathematicians, the successive drafts produced by the ministry, and explain the final rejection of the bill in 1834. The role of the mathematics and philosophy professor at the university of Leipzig, Moritz Wilhelm Drobisch (1802-1896), as well as the link between secondary and academic education will be emphasized. After studying the debates surrounding new regulations (Landtags-Acten, 1843), as well as the ensuing

gradual evolution in the 1840's (Cultusministerium, 1840; Cultusministerium, 1852), we will see that the new law issued in 1846 makes Saxony a somewhat favored place for the teaching of mathematics. We will finally try to explain a puzzling peculiarity of Saxony, that of the absence of any institution or regulation for the training of teachers in mathematics and natural sciences in the first half of the century.

"Mathematicus non est collega": Education in late eighteenth century Saxony

Secondary schools in late eighteenth century Germany were still governed by the school council, where the rector and the main teachers – in Latin, *collega* - were responsible for the educational policy of the institution (Schubring, 1991, pp. 27-32, 92-110). Most schools only had Latin and religion teachers, since most of the curriculum was dedicated to these two subjects, and Greek. Mathematics was typically reduced to the learning of the fundamental operations and arithmetic calculations (*Rechenkunst*). Since each professor was in charge of all the subjects for one class, this system was named *Gesamtunterricht*, as opposed to the *Fachklassensystem*, where a professor is responsible for the teaching of a single subject to many classes[1], or the *Jahrgangssystem*, where pupils with the same age are in the same class and subjects are taught by subject teachers. Until the beginning of the nineteenth century, mathematics in Saxony was virtually only present in the three *Landesschulen* of Meißen, Pforta and Grimma. These state-run schools were under the direction of the *Oberconsistorium*, the Saxon institution preceding the ministry of education created in 1831[2]. In most other schools, financed by the cities, there was no mathematics teaching, and the rudiments of arithmetic were usually taught by one of the Latin teachers or, less frequently, by a *Mathematicus*[3]. This person was not a full-time teacher and did not belong to the *collegae*. According to a historian of mathematical education writing in 1873, "at the beginning of the century, the teacher of mathematics had a relationship to the school that was almost as weak, perhaps, as today the relationship between the dance teacher and the school, if there even is one" (Heym, 1873, p. 40).

The *Mathematicus'* wages were particularly low, which explains why most of them had another job. Among many examples, we can cite the Thomasschule in Leipzig where a *Mathematicus* was hired in 1801 for 96 talers a year, when the rector earned more than 1000 talers. As late as 1834, the rector of the Gymnasium of Zittau regretted, that in the few schools possessing a *Mathematicus*, he usually earned less than 200 talers (Lindemann 1834b, p. 41). These factors – primacy of Latin and religion, low social status and wages for the mathematics teachers – explain the lack of social consideration for both the subject and the mathematics teacher. This situation is best summarized in the popular eighteenth-century saying "*Mathematicus non est Collega*". Lack of authority and unrest during mathematics lessons are frequently mentioned in

reports and only lowered an already deficient education[4]. In the second part of the eighteenth century, the philanthropic movement began to exert a powerful influence over the debates surrounding education in Germany, recognizing the need to introduce new subjects that were more modern and useful in civil life. These subjects, called *Realien* when referred to collectively, are history, geography, sport, French, English and, of course, the natural sciences and mathematics. The first and most famous philanthropic institute opened in Dessau, in the neighbor state of Sachsen-Anhalt-Dessau in 1774, and *Realschulen* – schools where the *Realien* have a great importance – are created in many north-German states (Paulsen, 1885, 482-490). Despite this proximity, the philanthropic movement had little if any influence in Saxony.

A year earlier, the government had issued a new regulation, namely the *Erneuerte Schul-Ordnung für die Landesschulen Meißen, Grimma und Pforta, sowohl der lateinischen Stadtschulen, ingleichen die deutschen und Dorfschulen, von 17 März 1773* (Schulordnung, 1773). This text was part of a broader movement of reform in Saxony following the Seven Years' War, the *Rétablissement*, whose aim was to modernize the country. In the field of secondary education this reform was a failure, for the simple reason that the state did not have real control on most schools, as they were funded and supervised by the cities. The *Schulordnung* was not only heavily influenced by the philologists; it was also a non-binding, indicative text with few precise indications about textbooks and the actual content of the subjects, and this holds especially for mathematics. It recommended teaching arithmetic in *Tertia* and applied mathematics in *Secunda* using the famous textbook of Christian Wolff. The main recommendation was not to lose too much time with mathematics, since students must chiefly master Latin, theology and Greek. Despite its vagueness and imperfections, this regulation would remain in force until the mid-1830s. Consequently the level of mathematical teaching remained very low in many secondary schools in Saxony; the few reforms were local and uncoordinated. The three *Landesschulen* of Pforta, Meißen and Grimma make for an important exception, since the state had a direct power over them and paid for competent teachers of mathematics: their presence has been attested for since the 1720's.

Philological and scientific conceptions of secondary education in Saxony

The main conceptions in the debate concerning secondary education in Saxony were conflicted on the very role that was to be assumed, not only by mathematics, but also by the classical school - at that time the only existing type of secondary school in Saxony. The dominant force at the end of the eighteenth century was clearly the philological movement: all rectors and most of the teachers had only studied Latin and theology in university, mainly Leipzig and Wittenberg, and the main subjects in all the classes were Latin, religion and Greek. Beyond the mere defense of their professional

interests, their discourses and arguments testified to a coherent *Weltanschauung*: the role of the classical school is to prepare one for university, which has then the task to deliver the knowledge necessary to be a *Gelehrter*, a scholar. M.W. Drobisch summarized it by ironically defining Saxony as the state "where philology is praised as a Panacea, as the real *medicina mentis*, where the being able to write and speak Latin well and being a learned man are identical concepts" (Drobisch, 1832, p. 59). The university was still heavily oriented toward the philological and philosophical sciences, seen as a necessary base knowledge to the study of any of the *Brotwissenschaften* (literally "bread sciences", *i.e*. theology, medicine, law and increasingly cameralism). Since the university was the only institution for higher education, it was very difficult to overcome these prejudices against mathematics. In an institutional frame where universities trained the elite of Saxony by assigning them the status of *Gelehrten*, mathematics and natural sciences play no role at all.

A second argument, often used to exclude the study of mathematics from schools, was its alleged difficulty and fruitlessness. In other words, philologists often claimed that some people were naturally gifted for calculations and geometry, and that other people could never learn it, which made any teaching pointless. Moreover, Latin and Greek, and sometimes the modern languages, were viewed as the only subjects whose practice helped to form and train the pupils' mind. They taught the general laws of thinking, and therefore their difficulty was worth the time spent learning them. On the contrary, mathematics was considered a sterile subject, since it did not teach one how to think, but only how to act upon matter, to master practical skills such as bookkeeping or land surveying. Some philologists progressively adopted a moderate position and accepted the idea of including some geometry, particularly Euclidian, in the curriculum of the classical schools. The subject was nevertheless overwhelmingly underrepresented in classical schools at the beginning of the nineteenth century, while applied mathematics and natural sciences were all but rejected from classical education.

These two arguments were used well into the nineteenth century, and as late as 1849, one of the most influential philologists in Saxony, wrote, "the very essence of the classical school is just as incompatible with excessively high expectations in mathematics and physics, as the *Realschule* is with such expectations in Latin and Greek. No more time and attention should be given to the former in the classical school than to the latter in the *Realschule*." (Köchly, 1845, p. 6) Hermann Köchly (1815-1876) studied in the 1830s at the university of Leipzig with the famous philologist Gottfried Hermann (1772-1848). According to F. Paulsen, "Hermann and his students and followers came from the Saxon state schools and universities, in which the old humanist teaching was still preserved, although somewhat modified by new ideas" (Paulsen, 1885, p. 639). After opposing in the first place any kind of scientific teaching in the Gymnasium, H. Köchly then adopted a more subtle and

nuanced approach. During the debate and negotiations about the reform of secondary education in 1845, he tried to reach a compromise while protecting the philological orientation of the Gymnasium. As we will see, the strength of the philologists explains why the philanthropic movement, powerful in other German states, has had little influence in Saxony.

As early as 1773, Johann Jakob Ebert (1737-1805), professor of mathematics at the university of Wittenberg, wrote a textbook for secondary school including mathematics, and emphasized the importance of the discipline for the practice of art and science[5]. Many mathematicians used this argument, and tried to open a debate about the role of the secondary education. According to the philologists, secondary classical schools were only required to train pupils for university, and mathematics should have been excluded from the curriculum since it was not a prominent academic discipline. At the end of the eighteenth century, mathematicians and mathematics teachers tried, on the contrary, to promote the idea of a secondary school preparing pupils not only for university, but also for technical or economical purposes, i.e. the practical life (*bürgerliches Leben*). But the regulation issued in 1773 preserved the existing situation and was a *de facto* victory for the philologists. The philanthropic conception, favorable to the introduction of mathematics, applied mathematics and natural sciences in classical school, was not to be heard. The intransigence of Latin and Greek teachers and rectors prevented classical schools from including or expanding the mathematics teaching. Unlike many other German states, the weakness of the state, or its lack of support to technical education, will did not even allow the creation of *Realschulen* at the side of the existing Gymnasium.

Government policies and the question of the application of mathematics

The role of the Saxon state in supporting the professional and industrial secondary education, which we will not study thoroughly here, has been ambiguous. Before the 1830s, the influence of the philologists and their efforts to control and supervise secondary education prevailed over the will to help and promote the burgeoning industry. Consequently, the government not only denied support to the creation of *Realschulen* or *Industrieschulen* until the mid-1830s, but also tried to prevent any individual initiative. In 1804, the body of inspection for education, the *Oberconsistorium*, informed the king that "many private-teaching and educational institutes have been recently been erected by clericals" (HStA Dresden, 10 094, Loc. 196, p. 1r). Judging that this posed a threat to the state education, the *Oberconsistorium* then asked to restrain and control the opening of such institutes. As an example, we see that Johann Carl Gotthelf Rochlitzer, teacher at the classical school in Freiberg, tried in 1807 to open a new school to train pupils to become "educated citizens, artists, merchant, miners, woodman, economist or soldiers" (HStA Dresden, 10 094, Loc. 196, p. 3v). The new regulation required him to send a plan, and we see that mathematics would have had a prominent place in the curriculum:

> "Mathematics, especially geometry and trigonometry will be taught three hours per week in the higher class, preceded by a special teaching in land surveying, for those who would have decided to the career in military, woodman, or economist, for which he [*Rochlitzer*] has already acquired the necessary apparatus. General calculation, including mental arithmetic, will be collectively taught six hours in all classes" (HStA Dresden, 10 094, Loc. 196, p. 3v).

His proposal remained unanswered, although a subsequent attempt in 1810 succeeded, leading to a quarrel with the local secondary school. This example highlights the general attitude of the government. The state was busy trying to regulate secondary education, and did not want to see its task made harder by allowing private professional schools to be created. But even in the *Landesschulen* where it theoretically had a direct control on the curriculum, there are reasons to question the achievements of the Saxon state in the area of mathematics teaching before the 1830's. The reforms between 1811 and 1820 (only for the *Landesschulen* of Pforta, Meißen and Grimma) led to an increase in the time devoted to the teaching of Greek, German, history and geography at the expense of Latin (writing and speaking). As F. Paulsen wrote, "Latin stopped to be an end in itself and became one teaching subject among others" (Paulsen, 1885, 647), but this does not necessarily mean an improvement of mathematics teaching[6]. On the contrary, the subject must have been neglected, since H. Köchly, who studied in Grimma from 1827 to 1833, asserted that not a word was spoken regarding algebra, and that the geometry lessons ended with the theorem of Pythagoras. He went so far as to say that "being a good mathematician was considered among us as a very dubious praise" (Paulsen, 1885, 648). A similar but somewhat improved situation can be observed in the *Landesschule* Pforta before the incorporation into the Prussian state in 1815. Mathematics was taught, but the most important subjects were Latin, Greek and Hebraic, and "anyone who wanted to count among teachers and pupils needed to be a master in these languages". There was a mathematics teacher, but "if one did not want to learn, he was not forced to […]. A pupil that devoted himself to it would earn respect, if he was a competent person, but would be seen as skylarking" (Döderlein, 1843, p. 270)[7]. The Prussian administration sought to improve the situation for mathematics, eventually abolishing the self-administration of the school in 1819, in order to lay down a new curriculum in phase with its neohumanist conception of secondary education[8].

Among the many influential philologists active in Saxony[9], one most radically opposed to the introduction of exact and natural sciences in the classical schools was Friedrich Liebegott Becher (1765-1830). He was rector of the Lyceum of Chemnitz from 1809 to 1830, and used his position to promote the teaching of classical languages, even though this city was the heart of the Saxon manufacture activity. According to him, "only philological studies and

studies of languages are convenient for the development of the intellectual activity" (Starke, 1897, p. 33). He recognized the usefulness of mathematics for the "general education of reason", but felt this could be done in one weekly hour conducted by a Latin teacher, reasoning, "with the countless bulk of books dealing with these topics, even a teacher not fully trained can achieve something". After trying in vain to reform the school, the government finally closed it in 1835, and a new higher industrial school (*höhere Gewerbeschule*) was opened.

In the 1830s, Saxony has reached a degree of industrial development that made many teachers and pedagogues aware of the need for mathematics and natural sciences in several new professions (Snell, 1834, pp. 5-10). It is difficult to determine the extent to which these contemporary claims correspond to an actual evolution in the social structure. Nevertheless, the fact that Saxony possessed many manufacturers and was in the vanguard of technological development in Germany prompted debates about the need for reform in the curriculum (Voss, 2005, pp. 17-21). In 1836 the industrial associations[10] obtain the creation of *Gewerbeschulen,* professional schools where applied mathematics and natural sciences are the main subjects, and ancient languages were sidelined. The role of the many actors implicated and the considerable amount of money the ministry of finance used to promote these schools have already been studied in some measure as a part of the Saxon industrialization (Kiesewetter, 2007, p. 523-527). But it should be emphasized that in the meantime the curriculum of many secondary schools (other than the *Landesschulen*) largely continued to follow the regulation of 1773, marked by the old humanist ideology. Latin was both the main subject and an end-in-itself, and the only goal was still to train pupils for university, with the rapid development of natural sciences being ignored. In other city schools, the rectors were moderate philologists and reform the curriculum; but most of the time, this only meant the development of German, Greek, history and geography. Mathematics was mostly taught at a very elementary level, for the "general education of reason" (F.L. Becher). In 1832, M.W. Drobisch resumed the conversation on the urgent need for introducing a new regulation for secondary schools to include mathematics and natural sciences:

> "If the state is thus of the concern, that public officials and teachers continuously maintain a certain intellectual dominance, then it must therefore demand from them knowledge that directly contain practical principles, on the application of which the arts, industry and commerce are based." (Drobisch, 1832, pp. 49-50)

The complete lack of any applied mathematical education in many secondary schools in Saxony was at that time becoming problematic even for people (officials and teachers) traditionally trained in classical schools and the university. At the beginning of the 1830s, the influence of the mathematicians and the manufacturers grows, as well as the public demand for a deep reform

of secondary education to match with the social and economic needs of the time.

Rejection of the education law : a setback for mathematics

Toward the end of the 1820s, things begin to change with the implementation of a maturity test (*Maturitätsprüfung*), inspired by its Prussian equivalent. First introduced in the state schools in 1818, it was then adopted in Freiberg, Zittau and Plauen in the following years before being generalized by an official mandate on July 4, 1829. Mathematics, which was at first only an oral test, became one of the three written examinations in 1830; the candidate had to prove his capacity of judgment (*Beurtheilungskraft*) as well as his mathematical knowledge.

In 1830, political unrest led to political reform that made Saxony a parliamentary monarchy. The old councils were rationalized or dismantled and proper ministries were created. The interior minister, also in charge of writing the new constitution was Bernhard August von Lindenau (1779-1854), a former astronomer therefore favorable to the teaching of sciences. Johann Christian Gottlieb Müller (1776-1836) was the first minister of education while Gottlob Leberecht Schulze (1779-1856) was appointed intimate school-councilor (*Geheimer Schulrath*). Schulze was a *Mathematicus* from 1803 to 1809 and then public servant since the 1820s in charge of the reforms of education in *Voigtland*, a district of Saxony. He was also astronomer and wrote numerous textbooks on these subjects. The creation of a ministry of education, whose leaders were aware of the existing flaws in secondary teaching, and favored the development of mathematics education, was widely seen by contemporaries as an opportunity for a comprehensive reform of school education and especially of mathematics.

Many professors and teachers, who until then could not publicly speak because of censorship, published books filled with criticisms concerning the state of mathematical education and proposals to improve the situation. Already in 1828, Adolf Peters, mathematics teacher in Dresden, had published a book, *About the study of Mathematics in Gymnasien*, in which he carefully deplored the fact that "in many Gymnasien the classical school subjects still stand sometimes in a secret opposition, sometimes in an open fight with mathematics" (Peters, 1828, p. 30). He then closely analyzed the methods and the goals of mathematical teaching, which he saw not as a mere sum of knowledge but also as a methodological tool necessary to learn the natural sciences, at the university or elsewhere.

The most famous book published to influence the reforms came from Moritz Wilhelm Drobisch (1802-1886), professor of mathematics and philosophy at the university of Leipzig (Drobisch, 1832). He offered a powerful case for a broad reform of mathematics education. To offset the lack of mathematical knowledge of students arriving at the university of Leipzig, he launched in 1827 a *mathematische Gesellschaft* proposing elementary lessons in

mathematics, but with little success. This led him to the conclusion that "if knowledge of mathematical elements is to become common property among students, then the Gymnasium has to complete this task, as it does with ancient languages" (Drobisch, 1832, p. iv). As the title of his book, *Philology and Mathematics*, suggests, he aimed at making mathematics the most important school subject along with ancient languages, collectively being viewed as "the two main branches of science and exert, with their heterogeneous nature, a various but decisive influence on the mind and its direction" (Drobisch, 1832, p. 2). He then took Prussia as an example of a land where every school had a *Mathematicus* and where substantial reform of secondary education has been carried out (Drobisch, 1832, p. 55).

Drobisch finished his book with a detailed plan for mathematical teaching in classical schools: "first, concerning the number of lessons, every pupil who enjoys mathematical teaching must have at least four weekly hours; however we do not ask for more than six, and these only for the first or both first classes, to use two of these hours in physics" (Drobisch, 1832, p. 76). The scope of mathematical teaching was in line with the then common definition of "elementary mathematics" and represented the knowledge necessary for entering university or a higher technical institute. Elementary geometry included arithmetic, algebraic geometry and trigonometry, but the close link he saw between solving problems and constructing figures strictly excluded any kind of analytical geometry. Elementary arithmetic was to be studied up to interest calculation, elementary algebra (*Buchstabenrechnung*) and quadratic equations. Higher equations was, in some cases, included in this program, "but differential and integral calculus lie undisputed in a whole new field" (Drobisch, 1832, p. 83) and were even considered dangerous for unprepared pupils.

This book and the proposals it contains would have a long-term influence on the debates in Saxony, due to the fact that M.W. Drobisch was a major figure in Leipzig's intellectual life, not only as a university professor of mathematics, but also as a famous philosopher and friend of Johann Friedrich Herbart (1776-1841). This plan was therefore seen as a compromise between mathematicians and philologists. Drobisch asserted the importance of mathematics without rejecting Latin and Greek, and these languages still made up a major part of the curriculum. The idea of a classical school based both on mathematics and ancient languages was therefore soon accepted by a large part of Saxony's scholars : mathematicians such as Karl Snell (1806-1886) recognized that "the laws of language (*Sprachgesetze*) contain the abstract form for every intellectual matter, as mathematics contain the abstract forms for everything natural" (Snell, 1834, p. 16). Karl August Rüdiger (1793-1869), rector of Freiberg's *Gymnasium* and philologist, published in 1833 a book named *On the association of language sciences and* Realwissenschaften *in classical schools. Suggestions and wishes* (Rüdiger, 1833), where he called for a

compromise (*Mittelweg*) between the current monopoly of philology and the system of *Realschulen*, where Latin and Greek were no longer school subjects[11].

In the second quarter of the nineteenth century, some philologists adopted a moderate view, asking for a reduction of the time devoted to Latin as well as the inclusion of new subjects such as mathematics in the curriculum. This moderate humanism of H. Köchly, K.A. Rüdiger of F. Lindemann should however be distinguished from the Prussian neohumanism for at least two reasons. First, the inclusion of mathematics was only a matter of concession to changed times, while mathematics and languages were not considered as equally important, the latter being considered the only true pillar of a proper classical education (Köchly, 1846, p. 79). The second reason is that most of those moderate philologists vigorously opposed the inclusion of applied mathematics and natural sciences in the curriculum. According to their humanist conception, these empirical subjects were not properly scientific and therefore should not be taught in the classical schools. Despite these reservations, moderate philologists and mathematicians agreed that mathematics teaching should be significantly expanded.

This debate had a direct influence on the ministry of education. In February 1832, the *Oberconsistorium*[12] informed the ministry that "the academic teachers in physics and related sciences of the university of Leipzig complained about the lack of a solid previous mathematical knowledge by the majority of students" (HStA Dresden, 11125, Loc. 11188, 1r). In 1832, G.L. Schulze consequently began to write memorandums and reports on this topic, in which he frequently cited M.W. Drobisch[13]. The following year, Schulze produced a bill reflecting the compromise that "languages and science contain together the formal laws of every being [*Dasein*], and must consequently be the two pillars of a formal education" (HStA Dresden, 11125, Loc. 11281, p. 76r-76v). The ministry then began to contact all schools to inquire into the current standards of mathematics teaching.

The results collated from secondary schools across the state showed the lack of mathematical teaching. However, the most urgent issue for the government was not school curriculum but school financing. Secondary schools, financed by heavily indebted cities, could not afford to appoint new teachers or to buy expensive mathematical and physical equipment. In fact, at the beginning of the 1830s, most schools did not even own a land map of Saxony. For the government, this was a unique opportunity to increase its power, and the new bill included both a substantial reform of education and state financing for many schools (7000 talers alone are dedicated to Freiberg, Zwickau and Plauen). This money was, however, conditioned by a strict control on curricula and the appointment of teachers. The government tried to avoid the mistake made in 1773, when the publication of a non-binding school program had no impact on the teaching of mathematics.

The draft of law was issued by the ministry on December 7, 1833, but in January 1834 the second chamber decided, in agreement with the first chamber, to adjourn the vote and asks for a deputation - composed of five members of the chamber – to conduct a survey on the bill. The adjournment was perceived by Friedrich Lindemann (1792-1854), the moderate philologist rector of Zittau, who published a book defending the reform the very same month, as a "public calamity" (Lindemann, 1834a, *Vorbemerkung*). The disagreements concerned the question of centralization, the integration of the *Realien* and the financial aspect: a member of the deputation remarked that "the government has not postulated enough for this, that 7000 talers cannot suffice, while for example in Prussia in 1830 one million and three quarters have been used" (Lantags-Acten, 1834, pp. 483, 517-518). It is important to note that most of the deputies agreed that some elementary mathematics is necessary, since they played the same role as classical languages in forming a "foundation for classical education": "among the classical writings were also those from Euclid, so that mathematics was included" (Lantags-Acten, 1834, p. 573). It was the applied aspect of mathematics, as well as of the natural sciences, that was fiercely criticized by conservative philologists. The mere introduction of natural sciences in the three first classes was condemned on the ground that "one cannot unite two directions, and one should not be allowed to serve two masters at the same time. Classical education should always stay the foundation" of the classical schools in Saxony (Landtags-Acten, 1834, p. 593). Despite the urgent need for money, the deputation and the chambers finally rejected the bill in July 1834, accusing it of spreading "the corrupting spirit of realism". F. Lindemann, himself a moderate philologist, wrote a second book criticizing this decision :

> "Even the fiercest denouncer of the government, who blames the school bill for the most blatant realism, cannot deny that mathematics and physics lessons are necessary in *Gymnasien*." (Lindemann, 1834b, p. 15)

Unable to attain its objectives with a legislative procedure, the ministry adopted a more subtle approach. On March 21, 1835, an edict was issued by the *Staatsminister*[14], granting the ministry of education factual control on many educational matters, including school organization and nomination of teachers (Cultusministerium, 1840, pp. 397-400). To reform the mathematical curriculum, the ministry planned to bypass the parliament and use a similar method, but an unfortunate confusion during the elaboration of the project prevented the harmonization process. In 1835, F. Lindemann sent a reform project to F.G. Schulze, with a detailed and comprehensive syllabus. The ministry found it relevant and forwarded it for examination to all rectors in Saxony. F. Lindemann was well known, having been one of the most successful rectors in Saxony, but he was no mathematician. Subsequently, his proposal concerning mathematics was not realistic and indeed very paradoxical: he only proposed two hours a week, but to please the

mathematicians he then set incredibly high goals for the four classes of mathematics :

> "Fourth mathematical class: elements of pure number science with the four operations and fractions (decimal fractions included), purely scientifically as algebra. One-year course.
>
> Third mathematical class: theory of powers, so far as necessary, proportions, progressions, logarithms, simple equations with instruction to the resolution of quadratic equations, but also planimetry up to the circle theory. One-year course. Second mathematical class: Theory of roots and root quantities, the main part of binomial law, continuation of planimetry, stereometry. One-year course.
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> First mathematical class: plane and spherical trigonometry, theory of equations of higher degrees, theory of curved lines ; elements of differential and integral calculus applied to curved lines. Two-years course." (HStA Dresden, 11125, Loc. 11283, §11)

If we compare this plan with what M.W. Drobisch had written in 1832, it is easy to see that Lindemann's plan is much broader while allowing mathematics only half of the time Drobisch found to be absolutely necessary. The reason is that Lindemann thought that mathematics was, in its very nature, much simpler than ancient languages and did not require the same amount of time and labor from the pupils:

> "I affirm that pure mathematics might be fully completed, thus far as it should be learned in the *Gymnasien*, in a three year course, and even slightly less with gifted minds, with only two hours of lessons a week, […] In mathematics a theorem result so much from another, the way of the advancing course is so consistent, that when the axioms are explained and proved, all the rest falls into place" (Lindemann, 1834a, p. 25)

This point of view is representative of a common misconception of the nature of the discipline among philosophers and philologists, according to which mathematics was more a sum of results and formulas than an actual discipline with its own difficulties. The plan laid out by Lindemann (who requested that he remain anonymous) attracted many answers from the rectors and teachers, most of them very critical of the mathematical components. Carl Gustav Wunder (1793-1850) was one of the most influential secondary teachers in the field of mathematics in Saxony, whose textbooks were, at the time, widely used. According to his rector, Wunder thought that "the mathematical teaching of the proposal is […], upon consideration of the subject matter, too broad for what is necessary and appropriate in *Gymnasien*; the elements of differential and integral calculus do not belong at the secondary teaching, and even spherical trigonometry is not necessary." (HStA Dresden, 11125, Loc. 11289/1, pp. 14v-15r). Many rectors and teachers

emphasized that this content would only be appropriate for a fraction of the pupils while others would either give up mathematics or learn it without understanding how to apply this knowledge.

M.W. Drobisch was among the few people to suspect that the author of the plan was not familiar with mathematics, and rightly claimed that this person "hardly had a clear view of the extent of the parts of higher mathematics that he wants to see taught in the first mathematical class. It is by now not possible to think of differential and integral calculus in the *Gymnasien*" (HStA Dresden, 11125, Loc. 11289/1, p. 23r). He also acknowledged that the plan is correct for the three first classes and could be taught with success if enough time was given to the teacher.

Trying to avoid the failure of 1773, the ministry decided to organize a conference with all school rectors, as well as various people involved in the reform of secondary education such as M.W. Drobisch. The invitations were sent along with the plan written by Lindemann, and from the 29 June to the 7 July 1835 the first conference about school teaching in Saxony took place. This was a clear demonstration of the new power of the central state over secondary schools, but the incoherence of the mathematical curriculum and the imbalance between its goals and its means could not ensure the harmonization and improvement in mathematical teaching. Once again, no binding decision or detailed prescription concerning mathematics could be reached. All things considered, the main achievement of these successive attempts to reform secondary school teaching was the gradual transition from the *Gesamtunterricht* system, which still prevailed in many schools at the beginning of the 1830s, to a system where each professor had to teach only one or two subjects[15]. Lindemann explicitly mentioned, for example, in the § 30 of his plan, the need for a specific teacher in mathematics and natural sciences. Since the average teacher in the 1830s gave about twenty lessons per week, this requirement would imply a significant increase in the time devoted to these disciplines and in concrete terms a professionalization of scientific teaching.

The regulation of December 27, 1846 and its aftermath

The mobilization of teachers, rectors and professors continued after the conference of 1835. In June 1835 Carl Gustav Wunder sent a report to the ministry about mathematics teaching (entitled *Einige Bemerkungen über den Unterricht in der Mathematik an Gelehrtenschulen*). A month later, M.W. Drobisch addressed a memorandum to the ministry containing new suggestions (*Ansichten und Vorschläge den mathematischen Gymnasialunterricht betreffend von Professor Drobisch zu Leipzig*) and attached a detailed program for the teaching of the mathematical subjects. On March 17, 1838, G.L. Schulze sent a report underlining the importance of mathematics in the curriculum (*Die Wichtigkeit des mathematischen Unterrichts auf gelehrten Schulen betreffend*). All these contributions clearly show that the mathematicians were not

satisfied with the existing situation, and that the teaching of sciences was still unsatisfactory in many ways. In fact, after having done much from 1833 to 1835 to improve the overall situation of mathematics teaching in the classical schools of Saxony, the government suddenly stopped, as if its goals had been reached.

In 1842, Georg Julius Hofmann (1812-1849) sent a report to the ministry to complain about the discrepancies in mathematical teaching in Saxony (HStA Dresden, 11125, Loc. 11512, pp. 38v-44v, *Die Verschiedenheit des mathematischen Unterrichts auf den Gymnasien betreffend*). Hofmann was representative of a new generation of teachers. He had not studied at the university but at the mining academy of Freiberg, who enjoyed at this time far superior mathematical teaching than Leipzig. He was appointed in 1836 at the *Gymnasium* of Freiberg, when the school was forced by the ministry to recruit a *Mathematicus*. He tried to make an assessment of the reform of 1835 and its impact on the teaching of mathematics:

> "Seven years have passed since that time, without that the well-meaning aim of the high ministry and the decision of all the then assembled rectors of secondary schools of Saxony have been introduced and achieved everywhere" (HStA Dresden, 11125, Loc. 11512, p. 38r).

His claims were based on a survey he carefully made himself. Hofmann had indeed sent a letter to each of his Saxon colleagues asking for exact conditions, number of classes and scope of mathematical teaching. The first and most important difference between the schools was the number of weekly lessons in mathematics, which he summed up in a chart reproduced here (HStA Dresden, HStA Dresden, 11125, Loc. 11512, p. 39r) :

Table 1 Number of weekly lessons in mathematics

	Cl. I.	Cl. II.	Cl. III.	Cl. IV.
Annaberg	2		2	
Budissin	war nicht zu ermitteln			
Dresden	2	2	2	2
Freiberg	4	4	4	4
Grimma	3	3	4	4
Thomasschule	2	3	3	3
Nikolaischule	3	3	3	3
Meißen	3	3	4	4
Plauen	2	2	4	3
Zittau	war nicht zu ermitteln			

Zwickau	4	4	4	3

To complete the overview given by G.J. Hofmann, we should add that the school of Zittau had no actual *Mathematicus.* Unable to reform the school, the government simply refused in 1837 to pay for a teacher, and opened a *Gewerbeschule* alongside with an extended science teaching; in the Gymnasium, the rector has to teach the discipline even if he was not a mathematician. In Bautzen (*Budissin* is the Latin name of the town) there was a proper *Mathematicus*, Georg Friedrich Theodor Koch (b. 1804) who taught two lessons per week in each of the four classes.

The main consequence of these disparities was a lack of unity in the scope of the curriculum: in Annaberg, where there were only two classes and two lessons per class each week, a pupil leaving school had only learned the square and cubic roots and the simple equations. In Freiberg, where the four classes had four lessons per week, the same pupil could master combinatorial analysis, higher equations, the theory of conic sections and spherical trigonometry. Hofmann proposed, as a solution, that the ministry "instructs one of the mathematics teacher to collect as soon as possible, during a personal visitation of the various Gymnasien of the fatherland, detailed plans about the extent of mathematical teaching" (HStA Dresden, 11125, Loc. 11512, p. 44r).

The minister's answer was a polite decline of the proposal, but G.J. Hofmann did not admit defeat. Understanding that it was almost impossible to reform the classical Gymnasium in Saxony, he then sent a petition directly to the parliament, asking for the creation of *Realgymnasien*, a second type of Gymnasium where the main subjects would be mathematics and natural sciences. His point of view, shared among others by K. Snell, was that there are two kind of scholars (*Gelehrten*), the classical ones and the people "who have chosen nature as the object of their endeavor" (Landtags-Acten, 1843, p. 242). He criticized the existing *Gewerbeschulen* for providing only technical and practical skills, and therefore for being unable to provide an education that trains pupils for the high scientific and functionary professions:

> "The *Realgymnasien* would be designed to achieve this goal, and would indeed also include the study of languages and history for the purpose of general education, but should make mathematics and natural sciences the main teaching objects, for these are the most necessary for their future profession." (Landtags-Acten, 1843, p. 242)

He mentioned experiences in other German states such as Bavaria, Baden, Württemberg and Prussia to declare that the best solution was not to expand the scientific curriculum of the Gymnasium, but to create a second type of schools. Students could then study in the mining academy in Freiberg, the forestry academy in Tharandt and even in some parts of the University of Leipzig (cameral, mathematical and natural sciences). The deputation of the

first chamber had a positive review of his work and concluded that Hofmann "does not act as a detractor of the current Gymnasium". It further recognized that "mathematics and natural sciences in their broadest scope are matters for a scientific research, as well as the ancient languages and history"; the deputation also acknowledged that "the consequences of these researches quickly find practical applications in the realm of industry" (Landtags-Acten, 1843, p. 251). Due to the lack of money, it nevertheless only recommended to turn an existent Gymnasium into a *Realgymnasium*.

The plenary discussion in the first chamber was revealing of the opposition of the conservative philologists to any projects including more mathematics in the Gymnasium. Christian Großmann (1783-1857), supported by the vice-president Albert von Carlowitz (1802-1874) expressed the "conviction that the classical education must be the foundation of every scientific education" (Mittheilungen, 1843, p. 1464), denying to mathematics and natural sciences any scientific pretension! Other members of the chamber did not support this claim, for they were aware of the prominent role played by mathematics and the natural sciences in the economic boom of Saxony. The interior minister B. von Lindenau himself refused to enter "the widely discussed and widely contested debate about the merits of Humanismus and Realismus" and focuses on the petition:

> "Concerning the petition of Mr. Hofmann, it seems to me noteworthy, because in a state such as Saxony, where business, commerce and factories represent a rich resource of the common prosperity, the means for an efficient professional education [*gewerblichen Bildung*] must not be lacking." (Mittheilungen, 1843, p. 1463)

Nevertheless, he did not agree with Hofmann's proposal, since he found the current professional and technical schools to be sufficient. He recognized that a majority of those pupils "enter practical life without a complete theoretical education", but still thought that the existing institutions could be improved without the creation of *Realgymnasien.* At the beginning of the 1840s, the associations dedicated to the advancement of industry had already succeeded in creating, with the support of the Saxon state, an alternative educational system. It was composed of two lower *Gewerbeschulen* in Plauen and Zittau, a higher *Gewerbeschulen* in Chemnitz and an institute for technical education (a kind of polytechnic) in Dresden.

After the second rector's conference in 1845, a new syllabus for the Gymnasium began to be discussed in the ministry and is sent to the rectors. Hofmann, who had been shown the proposal, wrote on August 17, 1845 to offer his opinion about the regulation. It was likely that the ministry simply took up Lindemann's proposal, since the criticisms were the same as in 1835. Even for Hofmann, whose teaching was probably the most ambitious in Saxony, it seemed "totally impossible to bring the pupils so far as to ask them

for a complete knowledge of the arithmetical series, series inversion, series for exponential quantity and logarithms". He went as far as to imply that the ministry was not aware of the contemporary state of mathematical teaching: "one can see from the programs of the Saxon *Gymnasien* that none of them carry his pupils as far as required in the § 56 of the regulation" (HStA Dresden, 11125, Loc. 11512, p. 47r, all underlinings are Hofmann's). He then referred to the many works of Drobisch as examples to base the improvement of the plan on, and asked for a consultation of the mathematics teachers before any official regulation.

Most of the moderate philologists were also opposed to this proposal, fearing that the extension of mathematics would take place at the expense of languages. Trying to influence the new curriculum, H. Köchly created in 1845 a society of Gymnasium teachers, the *Dresdner Gymnasialverein* (Flöter, 2009, p. 102). The same year, he wrote a book that was "sent to press in the greatest hurry, to arrive in time in the hands of the Saxon rectors, who had been called on Aug. 18 by the high ministry to debate, with some university professors, about the Saxon Gymnasium education" (Köchly, 1846, iii). In this book, he tried to preserve the central role of languages in the classical Gymnasium, which suggests that he did not oppose any kind of reform. Conscious that a reformation was needed, he asked for a comprehensive and general education: that the teaching of Latin should focus on the study of ancient texts, and the writing and speaking of Latin should be reduced in favor of Greek, history and new languages. He conceded that the sciences, including the natural sciences, should be part of a modern general education. Nevertheless, since he judged them too difficult for many students, they should "neither require homework, nor have an impact on the maturity certificate" (Köchly, 1846, p. 78). His reluctance towards mathematics came primarily from a lack of knowledge that he readily admits:

> "I would gladly explain further the scope, in which mathematics should be practiced in Gymnasium; but I frankly admit: I don't understand it […]. I only want to repeat here one thing: may one set not too high the standards in arithmetic and geometry!" (Köchly, 1846, p. 79)

We see that criticisms against the curriculum proposed by the government came both from mathematicians and from philologists such as H. Köchly or Franz Eduard Raschig (1802-1866). This arguably explains why the prescription published on December 7, 1846 is so vague concerning mathematics and natural sciences (Cultusministerium, 1852, pp. 96-122). Concerning mathematics, the prescription required four weekly lessons in every class, but the actual content was only described in some very general remarks (§55-56). Mathematics became one of the main subjects, but the primacy of languages, both ancient and modern, was reasserted. The preface written for the printed version of the prescription published in 1847 clearly showed the ideological distance between the neohumanist movement in Prussia and the moderate philologist movement in Saxony, indicating that

"no teaching subject is as suited to the development of the human mind as the language". If mathematics, history and natural sciences had their own teaching benefits, it was at least certain that "the totality of [language's] advantages is not combined in any of those" (Ministerium, 1847, p. 11). The prescription was however above all an attempt at tightening state control over secondary schools: they had to ask before changing the programs (§12) and the ministry was allowed to be present during the exams (§13). Having realized that a new syllabus must be based on a thoughtful analysis of the current state of teaching, the minister wrote the very next week to M.W. Drobisch, asking him to proceed with an examination of every secondary school and to attach a new plan to his report. In May 1847, Drobisch sent two voluminous and substantial reports to the ministry (HStA Dresden, 11125, Loc. 11512, pp. 94-137, 138-161). The first one was a detailed review of school teaching, including content of the programs, personality of teachers, salary, physical equipment, ability of the pupils, as well as the number and type of lessons. The second one was a reform proposal based on these observations. His global appreciation is surprisingly positive:

> "Admittedly teaching staff and teaching material are still lacking to some extent; but I am glad to have to admit, that I did not find any incompetent teachers of these sciences, and in fact many of them were very able and devoted." (HStA Dresden, 11125, Loc. 11512, p. 95v).

After this first positive impression, Drobisch gave a much bleaker overview of the mathematical teaching in Saxony. The salaries were usually very low, so that many teachers had to get a second job, which had deleterious consequences on teaching. In some schools the *Mathematicus* was indeed motivated, but still lacked of knowledge. Drobisch offered the examples of Bautzen, where G.F.T. Koch was an autodidact, and of Plauen, where the teacher Friedrich Eduard Thieme (1805-1878) spent too much time with "scientific subtleties" of the philosophy of mathematics and not enough with the actual and useful knowledge. In half of the schools, the number of weekly lessons was still below the requirement of the administration. Drobisch finally criticized the lack of unity among the various programs. Some of his main recommendations were better wages for teachers, a stricter use of the examinations and a more rational process of educating and selecting teachers. He finally asked for a conference of all mathematics teachers as a way of trying to unify the teaching of mathematics at a state-level.

Most of this advice, except that concerning the formation of teachers, was then taken up by G.L. Schulze in a report written in August 1847 and officially published in October. This final regulation set a fairly high standard for mathematics and made Saxony, after more than half a century of reform, a somewhat favored state for the discipline. A formal but important change concerned the goals and methods of mathematical teaching. The insistence on

a scientific teaching of mathematics shows the recognition of a third purpose beyond the general intellectual training and the practical calculating skills:

> "A third reason for cultivating the teaching of mathematics in classical schools, is that, if they must generally prepare pupils for university, then they should also prepare those who want to dedicate themselves to the special study [*Fachstudium*] of mathematics for this, by providing initial preparatory teaching through planned lessons." (Cultusministerium, 1852, p. 118.)

This was the first time that a regulation concerning secondary teaching in Saxony took into account mathematics as an established university discipline. Mathematics was still to be studied four hours each week, but the classes would only last a year instead of three half-years, evenly divided between arithmetic and geometry. This modification, which was a major demand of mathematicians, indicates the adoption of a new teaching organization, the *Jahrgangssystem*[16] and all subjects in Saxony were finally being taught in the same classes. After a *Progymnasium* where the pupils would learn the elements of calculation for two years, the syllabus would begin in the fourth class, the *Quarta*, with a revision of calculation, proportion theory and elementary geometry. In *Prima*, the pupils were supposed to learn in arithmetic the theory of combinations, the quadratic equations with many unknowns as well as "some general theorems concerning higher equations" (Cultusministerium, 1852, p. 116.). The geometrical part included goniometry, plane trigonometry, elements of analytical geometry and conic sections. Spherical trigonometry was only to be taught "if time permitted it", but solid geometry was obligatory and included the study of the spherical triangle, since many university courses (mathematical geometry, land surveying, astronomy) made use of it.

To understand how ambitious this program was, one should compare it first with previous teaching in Saxony, and then with programs in other German states, for example Prussia. In Saxony, some schools already had better mathematical teaching – for example in Freiberg, where Hofmann taught about higher equations and spherical trigonometry, or the *Vizthum Gymnasium* of Dresden; most schools had, however, approximately the same content while some others were clearly below this standard. This regulation must therefore be seen more as a tool to standardize mathematical teaching and tighten the control over the methods used during lessons rather than as a way to raise the standards. Compared to Prussia, the standard in mathematical education seems to be about equal, since the plans from 1834 and 1837 for example made no room for analytical geometry (Schubring, 1991, p. 64.). But a decisive difference between the two states lay in the dynamic of mathematical teaching. After a golden age in the 1820s, Prussia saw in the following decades virulent criticisms against mathematics, partly inspired by the philological movement on the Saxon model (Schubring, 1991, pp. 60-64). In Bavaria, the history of mathematical education was very dependent on the

political context, with two reforms inspired by the French model in 1804 and 1808, before a return to the old humanist conception after 1816[17]. From 1822 on, mathematics teaching began to expand, but one had to wait until 1854 to see the scientific subjects form a sizable share of the general teaching (Schubring, 1989, pp. 284-285). On the contrary, Saxony saw a constant improvement of mathematical teaching at all levels, since its mathematical teaching was very low at the beginning of the century. These improvements mainly concerned the number of weekly hours of teaching, the extent of the syllabus as well as many reflections and improvements in didactic. There were connections between secondary and higher education, particularly due to the work of M.W. Drobisch (see Drobisch, 1832), so that the ministry of education progressively considered the teaching of mathematics at both levels as a whole. These connections, as well as the growing influence of mathematicians, help in explaining why Saxony did not experience during the 1840s a stagnation to a low level as in Hessen (Schubring, 2012, pp. 530-532), nor the reduction of mathematics teaching that happened in Prussia (Schubring, 1991, pp. 90-91).

The ministry became increasingly powerful and exerted tighter control on mathematical teaching, symbolized by the inspection of M.W. Drobisch in 1847. Other steps were taken: in 1848 the maturity test was reformed (HStA Dresden, 11125, Loc. 11472, p. 247r-247v) and textbooks were to be chosen among an official list[18]. In conclusion, the reform of mathematics education in Saxony was a gradual process that helped mathematics teaching reach a fairly high standard at the end of the 1840s, roughly equivalent to its Prussian counterpart. Teachers were more and more seen not only as educators but also as mathematicians and potential researchers. In fact, the number of mathematical publications increased in this decade, especially in the scientific essays attached to the yearly programs published by secondary schools. Aware of the importance of the association between research and teaching (*Forschung und Lehre*), M.W. Drobisch suggested in 1847 that "it would also be good if these teachers had less rarely than now to write a program, and received the opportunity to give proofs of their continuous scientific ambition" (HStA Dresden, 11125, Loc. 11512, p. 145v). At the end of the decade, the only issue left to solve was the lack of training and evaluation for mathematics teachers.

The training of mathematics teachers, an absent issue?

"For the training of mathematics teachers, too little had been done in all respects. It was not enough that mathematical courses in the university were taught by competent, or even renowned men, whose teaching the acquaintance opportunities were presented to young men to enter as deep as possible in science!" (Drobisch, 1832, p. 98)

The professionalization of mathematics teaching that happened in many European states during the nineteenth century was a complex process

(Schubring, 1991; Delve, 2003; Hulin, 2007). It included an improvement of the mathematician's condition, the introduction of examinations or selection processes, as well as training for future teachers. It was commonly assumed that the professionalization of mathematical teaching was accompanied by selection and training of the new teachers, since these steps were usually concomitant. However, these three elements, individualization of the subject, creation of an official examination, and institution of training for teachers, did not appear simultaneously in Saxony. We have seen that mathematics was factually one of the main subjects since the middle of the 1830s; all schools in Saxony progressively recruited a teacher solely dedicated to mathematics and natural sciences. Unlike the former *Mathematicus*, these teachers ere members of the *Collegium*, which means that by the middle of the century they got – though laboriously - a role and remuneration equivalent to their peers. An examination by the state of future teachers was, however, only introduced in the 1840s, while the idea of clearly defined training for mathematics and science teachers at the university of Leipzig, discussed on many occasions, was repeatedly rejected until 1881.

The issue of the training of primary schoolteachers will not be discussed here in detail[19], but it is useful to understand the nature of the problem: schoolteachers were usually trained in a *Lehrerseminar*, and having studied in a *Gymnasium* was, sometimes, enough for primary teaching. Therefore the education of teachers largely stayed a local issue, each city having its own *Lehrerseminar*. For secondary teaching, the only difference was the necessity to study at the university. The usual training, at the turn of the nineteenth century, was the study of theology in Leipzig or Wittenberg, as well as other introductory courses about disciplines such as history, sciences and philosophy. Leopold Imanuel Rückert (1797-1871) was representative of this old generation of teachers. Born in the village of Herrnhut, he went to the *Gymnasium* in the neighboring city of Zittau before studying theology and philology in Leipzig. Back in his homeland, he first became deacon from 1819 to 1825, and then switched to education. From 1825 to 1844 he was subrector in the classical school of Zittau. Besides Latin, he also taught mathematics without specific education or knowledge, only because no other teacher wanted to do it. The state refused to pay for a proper *Mathematicus* (see above), and so it was only when Rückert left Zittau to be appointed theology professor in Jena that a specific teacher with a scientific education, Gustav Adolph Jahn (1804-1857), was appointed.

In the first quarter of the century, the university of Leipzig had a *de facto* monopoly over the education of secondary teachers, being the only general academic institution in Saxony, but it did not offer any specific lessons for future them. In 1847, H. Köchly recognized during a debate that “the total lack of sufficient institutions for a proper education of Gymnasium teachers is a great affliction of Saxony. Not only the teacher of natural sciences, but also the teacher of ancient languages and history does not find in Saxony any

sufficient practical education", while another debater states that "the university offers nothing to the one who plans to become a teacher" (Reichenbach, 1847, p. 111-112). It was nevertheless the main place to look at in order to study the first projects and their failures. A mathematical society (*Mathematische Gesellschaft*) was launched by M.W. Drobisch in 1827, delivering free courses on Saturdays for students and future teachers. We have little evidence about this society, recognized but not supported by the university. In 1832, Drobisch deplored the lack of any financial help to the students, explaining that "the students who participate to these private institutions do not benefit from grants like those in seminars" (Drobisch, 1832, p. 99). It seems that M.W. Drobisch finally stopped the society in 1833, discouraged by the lack of enthusiasm of the students and regretting the absence of a state-funded institution to train mathematics teachers: "Nothing has so far been announced about a nursery [sic] for secondary teachers in mathematics supported by the state, tough it seems that such institutions could be brought to life without high costs" (Drobisch, 1832, p. 98)[20]. In the same book, he explains that he "has in the past already published in journals some short articles about those topics, but anonymously, because […] he was aware that his name could not put an authority significant enough to tip the scales" (Drobisch, 1832, p. vii).

The bill written in 1833 by Schulze contained an "addendum concerning the training and examination of future, as well a current secondary teachers" (HStA Dresden, 11125, Loc. 11281, pp. 39v-58r). Schulze referred to the book of Drobisch and asked for special lectures in Leipzig for future teachers. He then explicitly mentioned Prussia and Württemberg to demand the creation of a "scientific examination committee". The same year, the minister Müller asked the university to produce a plan for the formation of a Seminar dedicated to natural sciences. The first draft presented by the professor for chemistry Otto Limmé Erbmann defined this seminar as "the best way to form teachers for the elementary schools and the *Gewerbeschulen*" ; aimed directly at forming teachers and asked that "the state preferably considers the members of the seminar for the appointment in schools" (HStA Dresden, 11125, Loc. 10219, pp. 4v, 5v). This draft was inspired by the model of the *Seminare für gelehrte Schulen* introduced in Prussia since 1825 (Schubring, 1991, p. 122), and was to be distinguished from the latter scientific *Seminar*, an institution whose goal is to introduce the most advanced students to the current state of research. The philosophical faculty concluded that the future *Seminar* should also include mathematics. Heinrich Wilhelm Brandes (1777-1834), professor of physics at the university of Leipzig, told the ministry about Drobisch's mathematical society as a possible starting point for a new institution and sent a draft proposing an "institute directly supervised by the high ministry of cult and managed by the three professors of mathematics, physics and chemistry" (HStA Dresden, 11125, Loc. 10219, p. 15r). Brandes proposed a seminar for ten students, chosen after two or three semesters at the university. These students would get grants and study in the seminar for

two years before taking an oral test. Although the seminar had only the function to train secondary teachers, his objectives were fairly high:

> "The three professors will commit themselves to organizing their lectures, and selecting those which are not merely designed for beginners, so that the *Seminaristen* can attend in two years: a curriculum in higher mathematics, a complete sequence of lectures about the different parts of physics and astronomy and about the important applications of chemistry in art and industry." (HStA Dresden, 11125, Loc. 10219, pp. 17v-18r)

This proposal was clearly an attempt to formalize another informal initiative of M.W. Drobisch. The university programs show that, since the summer semester of 1828, Drobisch had begun to organize of his own volition his teaching activity in this sense, announcing the "opening of an estimated 3 years curriculum of theoretical mathematics" (Vorlesungsverzeichniße, 1828). Afraid of the possible costs, the minister quickly dismisses the plan while praising the informal initiatives already taken by the professors and encouraging them to continue. The minister's refusal of any institutionalization of this informal teachers seminar would consequently cause M.W. Drobisch to transform it into two-semesters of higher mathematics from the summer of 1835. This refusal, as well as the rejection of the bill concerning education, would prevent any attempts to create a seminar for mathematics teachers at the university of Leipzig for more than a decade. Thanks to the efforts of M.W. Drobisch, H.W. Brandes and A.F. Möbius, the number of students in mathematics and natural sciences nevertheless grew in the late 1830's and the 1840's, and many of them became teachers.

In 1843, a scientific examination committee was created at the university of Leipzig. There was no specific committee for mathematics and natural sciences, even though in the actual school teaching, the profession of mathematics teacher was already distinct from the generic *Klassenlehrer* who taught all the other subjects. Since the members of the commission were professors of the philosophical faculty, the relative weight of philosophy, theology and philology made science a subsidiary discipline. In 1848 a new regulation was published concerning the examination of future teachers, the *Regulativ, die für die Kandidaten des höheren Schulamtes zu haltenden Prüfungen betreffend*, creating three different specific sections. The first was for generic teachers in classical schools (*Gymnasium*), while the second was for generic teachers in elementary and professional schools. The last sections examined the future scientific *Fachlehrer*, *i.e.* the mathematics and natural sciences teachers, for all kinds of schools. Incidentally, this meant that the same examination was required for teaching mathematics in classical and in technical schools. The future mathematics teacher would not merely be a specialized teacher but would also possess a general education (*Allgemeinbildung*): the written part of the examination contained "an elaborate scientific work in the field of mathematics and natural sciences, and

moreover a stylistic work about a philosophical or historical subject" (Cultusministerium, 1852, p. 135). Besides the sciences, the oral test included pedagogy, philosophy, history, geography, history of culture and literature. The generic test for Gymnasium teachers now contained several written and oral examinations, about philosophy, history and ancient languages. Nevertheless, it should be emphasized that no mathematical knowledge was required for these *Gymnasiallehrer*. The test for generic teachers in elementary and professional schools only mentioned an oral examination on the "elements of arithmetic, geometry and natural sciences" (Cultusministerium, 1852, p. 134). Moreover, the university lost its old monopoly, since it was now sufficient for a candidate to prove that "he has had the opportunity to acquire a scientific knowledge of the disciplines in question in a polytechnic or higher industry school" (Cultusministerium, 1852, p. 133). In the two following decades, about a third of the mathematics teacher candidates came from the polytechnic school in Dresden (Voss, 2005, p. 22).

The inability of the university to create a proper training institution for teachers has therefore had deep consequences. This permission given to the technical institutions to train mathematics teachers testifies to the recognition of their rising importance and of the key role they now played in the training of scientists in Saxony: in the second quarter of the nineteenth century, at least fifteen of the secondary mathematics teachers had studied either in the technical institute of Dresden or in the mining academy in Freiberg[21]. They taught not only teach in professional institutes, but also in classical schools in Zittau, Dresden, Freiberg, Leipzig and Annaberg. At the end of the 1840s, M.W. Drobisch explained in his report that an examination, even dedicated to mathematics, can only be a partial solution: "this is not yet sufficient […]. In the profession of teacher, the quantity of mathematical knowledge acquired is not the only referential" and underlined the importance of a specific training for mathematics teachers, saying that "much can be gained by academical seminars" (HStA Dresden, 11125, Loc. 11512, p. 143r). He also suggested the introduction of a probationary year, theoretically introduced in 1846 but still not in force. Mathematical teaching was therefore still not fully professionalized since there was no such thing as a common seminar and people from very diverse backgrounds could become teachers without any specific training. This issue was of primary importance considering the shortage of mathematics and natural sciences teachers. The necessity of finding enough people can prejudice the goal of an *Allgemeinbildung* for science teachers, while an institution ensuring a common training would have been an appropriate solution.

At the end of 1847, Gotthard Oswald Marbach (1819-1890) sent a report to the ministry about the possible creation of a seminar dedicated to mathematics and natural sciences. G.O. Marbach had been teacher in the *Nikolaischule* in Leipzig and *Privatdozent* at the university since 1833. He planned to create a seminar at the university, where students coming from the many schools of

Saxony could revise elementary mathematics, because "only very few of them are so prepared, that they can readily begin with the study of mathematics and natural sciences" (HStA Dresden, 11125, Loc. 10219, pp. 35r-35v). It has a much lower standard than the proposition made by H.W. Brandes and M.W. Drobisch in 1834 in which students were supposed to learn higher mathematics. This draft, was, however well-received by the ministry, partly because Marbach set up a petition signed by 42 students. Consulted about this proposal, the philosophical faculty accused Marbach of advocating the creation of a seminar to make money and to feature on the lecture program of the university, from which *Privatdozenten* were normally excluded. Criticizing the low level of the lectures offered and Marbach's mathematical skills, the faculty blamed him for endangering the reputation of the university and the interest of science! The faculty nevertheless acknowledged the need for a training institution for teachers:

> "It has already long ago been identified and discussed by many members of our faculty, that a seminar, intended to the training of teachers of mathematics and natural sciences in the secondary classical, professional and special schools, like some already exist in other universities such as Halle, Königsberg and Bonn, is a necessity of our time." (HStA Dresden, 11125, Loc. 10219, pp. 35r-42v)

After this negative report, Marbach's plan was logically abandoned, but in spite of the need for a scientific seminar, nothing happened for almost two years. In 1850, G.O. Marbach had become member of the examination committee, and sent the same plan again, stressing on the need for an elementary training in mathematics for students and future teachers. Without even asking the faculty for a report, the ministry refused to give any kind of financial or institutional support. A scientific mathematical seminar would first be created in Leipzig thirty-one years later.

Conclusion

In conclusion, we see that the history of mathematical education in Saxony can only be understood in the broader context of the reforms of the state and of the university. The weakness of the public authority and the inertia of the secondary schools, backed up by the *status quo* of 1773, could not be overcome before a proper ministry for public education was created in 1831. For the two following decades, the archives of the Saxon *Ministerium des Cultus und öffentlichen Unterrichts* reveal the complexity of many issues concerning the secondary education, as well as the numerous contributions to the reforms. If the training of teachers seemed to be absent from the public debate, this does not necessarily suggest that the education of teachers was not an issue in Saxony, rather it only means that the various plans sent to the ministry had been rejected for financial and political reasons. The archives show that this question was debated both in the university and in the ministry, but no

agreement between these institutions could be reached. The reforms of mathematics education in Saxony was not – as in Prussia – part of "a systematic reform of the entire educational system" and the result of a "reconstruction of the secondary schools and the universities and of the relation between these two subsystems" (Schubring, 2012, p. 527). It was a gradual and somewhat spasmodic process, with many setbacks and delays in the implementation of the decisions taken by the government.

Another important point is the key role played by mathematicians: G.J. Hofmann in Freiberg, K. Snell in Dresden, C.G. Wunder in Meißen and especially M.W. Drobisch in Leipzig. Their numerous publications and often unsolicited reports contrast with the apparent lack of action of the government, and allow us to observe another difference between Saxony and Prussia. While the latter actually succeeded in pushing a neohumanist reform forward in the 1810s, the moderate philologists in Saxony only brought about an extended teaching of Greek, history and modern languages, while other parts of a general education such as mathematics and especially natural sciences lagged behind. Nevertheless, classical secondary teaching gradually became more inclined towards the natural sciences and mathematics from the 1830s. This was partly due to the influence of the Saxon industry that led to the success of the *Gewerbeschulen*, where mathematics and natural sciences were the backbone of the curriculum[22]. The economy had developed in a manner that proved the one-sided classical education at the secondary level to be outdated. It is also linked to the development of a new tradition of applied mathematics at the university of Leipzig and in the higher technical institutes (Schlote, 2004). It was finally, most importantly, a consequence of the reorganization of the Saxon state, which saw its influence growing concurrent with its role in financing the secondary schools.

Notes

[1] Some reflections about transition to the *Fachklassensystem* can be found in (Schubring, 1991), chapter 7, *Übergang zum Jahrgangsklassensystem*, pp. 92-110. The influence of philanthropismus seems to have been more important in Prussia, which subsequently adopted sooner a *Fachklassensystem.*

[2] The *Oberconsistorium* rounded up some high government and church officials, and was in charge of the issues related to religion and education. It had direct authority on the state schools, but could only give advice to the universities and the city schools through the local *Consistorien* present in the Saxon districts. In spite of its lack of power, the *Oberconsistorium* seems to have been a progressive institution at the end of the century. Some of its members such as Peter von Hohenthal (1726-1794), one of the authors of the regulation issued in 1773, were influenced by the pietist movement. P. von Hohenthal even tried to found a *Realschule* in Wittenberg, on the model of Halle and Berlin. This explains why the *Landesschulen* began to teach modern languages, history, mathematics and natural sciences from the beginning of the eighteenth century on.

[3] There were about twenty secondary schools in Saxony at the end of the eighteenth century, and the teaching of sciences was mostly very low, but far from being homogeneous. In one of them, the Gymnasium of Bautzen, one could find a proper mathematics teacher, Ehrenfried Traugott Demuth (1738-1799); he even became a rector of the school at 1781. The other schools were the Lyceum Annaberg, the Lyceum Chemnitz, the Kreuzschule Dresden, Bürgerschule Dresden-Neustadt, the Gymnasium Albertinum Freiberg, the Thomasschule and Nicolaischule Leipzig, the Königliches Gymnasium Plauen, the Lyceum Schneeberg, the Bürgerschule Zittau and the Gymnasium Zwickau. Those were only the schools part of the Saxon territory after 1815.

[4] In the *Gymnasium Albertinum* in Freiberg, the *Mathematicus* hired in 1822, Breithaupt, left the school three years later because of pupil unrest. The school then had no mathematics teacher until 1830, when the maturity test introduced in Saxony makes it necessary. In Plauen, at the end of the eighteenth century, unrest led three successive rectors to resign. The issue of authority in schools was to make mathematics of first importance, since its unsteady place in school curriculum made it particularly vulnerable to troubles.

[5]The title of the book was *Nähere Unterweisung in den philosophischen und mathematischen Wissenschaften für die obern Classen der Schulen und Gymnasien.* Leipzig: Hertel. His precise assertion was that "the merchant and the artisan can be brought in the position to bring his manufacture to a much greater perfection" (p. 57). But this argument was of little weight, since the classical schools and the university don't usually train merchants and artisans.

[6] According to J. Flöter, these reforms were influenced by the Leipzig neohumanist movement (Flöter, 2009, pp. 55-56). However, the use of "neohumanism" was contested by other scholars such as G. Schubring, and will be discussed later in this paper ; it should be noted that these reforms do not present mathematics as one of the main subjects, as was the case with the neohumanist movement in Prussia.

[7] This marginal position of mathematics teaching was confirmed by the *Landesschule* Pforta, where mathematics was neglected since the end of the eighteenth century. Upon first inspection by Prussian authorities after its incorporation into the Prussian states in 1815, the Prussian commissar demanded that the mathematics teacher no longer be regarded as having the same position as the "maîtres", the instructors for dancing, singing and fencing (Schubring, 1985, p. 24 & 26).

[8] A detailed analysis of the efforts of the Prussian state to improve the mathematical teaching in Schulpforta can be found in Schubring, 1985, p. 24-25.

[9] F.L. Becher had studied at the university of Leipzig, and had been member of the philological seminar founded by Christian Daniel Beck (1757-1832). Philological seminars such as Beck's or G. Hermann's were frequented by most of the future teachers and rectors in Saxony. They had therefore a conservative influence against education reforms in Saxony, with nevertheless notable differences. G. Hermann had a neo-humanist view that led him, for example, to consider the new languages such as French or Italian, as well as history, worth learning in the Gymnasium.

[10] These associations are the *Ökonomische Gesellschaft im Königreich* Sachsen, founded in Dresden in 1816, and the *Industrieverein für das Königreich Sachsen,* founded in Chemnitz in 1828 and represented the machine building companies. Their negotiations with the *Landes- Ökonomie-, Manufaktur und Kommerziendeputation*, that represented the parliament, led to the creation of the *technische Bildungsanstalt* in Dresden (1828, later polytechnical school Dresden) and the *Gewerbeschulen* in Plauen, Zittau and Chemnitz (1835-1836).

[11] For another example of the complementary role of mathematics and ancient languages, see Lindemann, 1834a, pp. 21-25).

[12] *The Oberconsistorium* temporarily outlived the reforms as an advising board, and was disbanded in 1835.

[13] These documents are collected in HStA Dresden, 11125, Loc. 11181, *Entwurf zu einem Gesetz für die Gelehrtenschulen (1833)*. See for example p. 41r for a reference to Drobisch. Schulze shared almost all the views expressed by M.W. Drobisch. He wished to use more time and money for teaching the *Realien* and technical matters (see p. 18v), wanted training and an examination for teachers (pp. 47r-49v). Nevertheless, his drafts always remained vague concerning the content of mathematical teaching.

[14] *The Staatsministerium* was the government of Saxony, and corresponded to the *Geheimes Consilium* before the reforms. The *Staatsminister* directed the *Staatsministerium* and had vast executive powers; in 1835, it was Bernhard August von Lindenau.

[15] Many schools kept on using the *Gesamtunterricht* system. In the Thomasschule in Leipzig, for example, the *Mathematicus* and the French teacher were part of the *Collegium* since 1828, but for each class a Latin teacher was still in charge of the main teaching (*Klassenlehrer*).

[16] *In the Jahrgangssystem*, pupils were in a class according to their age, while in the previous *Fachklassensystem*, pupils were divided according to their relative skills. See (Schubring, 1991) and the second note.
[17] See Schubring (2012, pp. 528-529). A detailed account of the secondary reforms in Bavaria, and of the key role played by Friedrich Tiersch (1784-1860), can be found in Paulsen (1885, pp. 651-664).
[18] The introduction of a ministerial control on textbooks seems to have occurred in successive steps. After asking every school about the textbooks used in 1840, the ministry called the university for a report concerning the introduction of a single mathematical textbook in Saxony. The university took a stand against this proposal, for fear of a « *setback into scholastic barbarism* ». From 1835 on, each school should have chosen a book among a list drawn up by the ministry, and should have asked and notified each change of textbooks. In practice, this seemed to have been the case only from 1848. See for details HStA Dresden, 11125, Loc. 11482, *Acta, die bei dem Unterricht in der Religion, Geschichte, Geographie und Mathematik in den gelehrten Schulen einzuführenden u. verbotenen Lehrbücher betr.* (1839-1853).
[19] For further information about how the training of primary teachers became a state responsibility, see HStA Dresden, 11125, Loc. 11258, *Acta, die Errichtung eines landlichen Schullehrer Seminars betr.* (1837).
[20] In his diary, we find some pessimism regarding the same, for example in 1832: "I'm not really satisfied with the math. society" (UAL – Nachlass Drobisch, Tagebuch, t. 3, 7 July 1832). The society was recognized by the university since it appeared on the official programs (*Vorlesungsverzeichnis*). It was however not encouraged, since a financial support was given neither to M.W. Drobisch nor to the students. In 1834, hesitating to reintroduce the society, he deplored the lack of interest and energy of its students and the uselessness of its efforts. He thought that an official seminar, with grants for some students, would attract much more people than his private society. See HStA Dresden, 11125, Loc. 10219, *Begründung eines mathematisch-naturwissenschaftlichen Seminars zu Leipzig* (1834-1850).
[21] The list is not exhaustive, given the difficulty in finding information about the least known individuals. It includes: from the technical institute in Dresden, Hermann Bleyl (1814-?), Karl Franz Dietzel (1820-?), Karl Osmar Fort (1817-1881), Friedrich Gottlob Kohl (1801-1876), Karl Kuschel (1814-1899), Ludwig Oberreit (1821-1906), Maximilian Robert Preßler (1815-1886), Christian Moritz Rühlmann (1811-1896), Theodor Schenker (1806-?) and Carl Heinrich Schmidt (1818-?) ; from the mining academy in Freiberg, Anton Hallbauer (1814-1891), Georg Julius Hofmann (1812-1849), Julius Ambrosius Hülße (1812-1876), Christian Friedrich Schubert (1808-1874) and Julius Weisbach (1806-1871).
[22] Although the *Gewerbeschulen* had at first a lower social status than the *Gymnasium*, their success in training officials and technicians soon became a challenge to secondary classical teaching.

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