TEACHING HISTORY OF CHEMISTRY IN EUROPE

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Version 2.0 – November 2007

The current report is based on the information sent by many colleagues and teachers of history of chemistry in Europe. It is a project of the Working Party on the History of Chemistry EuCheMs[1] and has been coordinated by José Ramón Bertomeu-Sánchez with the help of Ernst Homburg and Evangelia Varella.[2] The report gathers information about the teaching of history of chemistry in European universities during 2005 and 2007. An important reform of European universities is taking place, so the data offered by this report will probably change during the following years. The purpose of this report is to provide factual information and to suggest guidelines about the future place of history of chemistry in the European universities. It includes several national reports alphabetically organised by the name of the countries. I am very grateful to all the contributors who have kindly provided the most substantial parts of the following pages. Some conclusions and suggestions are offered at the end.

Introduction

History of chemistry has been taught in European universities since chemistry was introduced as a part of university curricula. Eighteenth-century chemistry textbooks usually contained a large introduction on the history of chemistry.[3] Many books and papers on history of chemistry were published in Germany and Britain at the beginning of nineteenth-century by famous chemists such as Gmelin or Thomson. As early as in 1837, Jean Baptiste Dumas lectured a whole course on "chemical philosophy" at the Collège de France in Paris and the main focus was the history of chemistry. By the middle of the nineteenth-century, history of chemistry was taught as a separate course in the university of Giessen by Hermann Kopp (1817-1892) who published one of the first important books on history of chemistry [4]. During the next years, many other publications on the history of chemistry were published by other European scholars such as Ferdinad Hoefer (1811-1878) (*Histoire de la chimie*), Albert Ladenburg (1842-1911) (*Vörtrage über die Entwicklungsgeschichte der Chemie*) and Adolphe Wurtz (1817-1884) (*Histoire des doctrines chimiques,* which was part of his famous dictionary of chemistry)[5] Many other chemists-historians published papers on history of chemistry or included substantial historical information in their textbooks and lectures.[6] At the beginning of twentieth century, history of chemistry became a blossoming academic discipline inside the larger field of history of science. New institutions and new publications (Isis, 1913; Ambix, 1937, etc.) appeared and important books were published by famous historians such as Hélène Metzger, Aldo Mieli, Julius Ruska, etc..[7] At the same time, history of chemistry was taught by chemistry lecturers who wanted to introduce a more humanistic view of their discipline or renovate the way in which chemical concepts were introduced[8] As a result, different and somehow independent lines of work in history of chemistry have been developed by historians of science, chemists and other authors during the second half of twentieth century. The existence of different traditions, methods, purposes and approaches can be found in the following reports on the teaching of history of chemistry in Europe. [9]

THE SURVEY

The survey gathers information about 21 European countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Russia, Slovenia, Spain, Sweden, UK.

AUSTRIA[10]

The history of chemistry is taught at the Technische Universität Wien in the Faculty of Chemistry as 3 optional ECTS for advanced students. R. W. Soukup offers lectures on "Chemical History" (2h) but also an introduction to "Philosophy and History of Science" (3h).[11] In some cases, further exercises (8h) on history on science can been written by students when preparing their "Diplomarbeiten".[12] At the University of Vienna a course “History of Chemistry” (1 h) is given by Prof. Dr. Adolf Mikula to all students becoming teachers of chemistry. At the University of Graz Prof. Dr.Alois Kernbauer has given courses from 1991 to 2000 (2 h), which included certain aspects of history of chemistry At the University of Linz Doz. Dr. W. Gerhard Pohl has given several courses on history of chemistry (2 h) for students becoming teachers of chemistry. The last course was given in SS 2000. In 2001 a new curriculum for chemistry teachers was introduced, which did not contain courses for history of chemistry. So the lectures did not continue.

BELGIUM[13]

There are only few universities in Belgium that ever offered a course specifically devoted to the history of chemistry. Some of these courses seem to disappear as the professors in charge retire and the new Bologna system is installed. Most of the teaching of the history of chemistry is thus included in general history of science courses. But even these general courses do not exist in every Belgian university: there are no such course at either the University of Liège or the Université catholique de Louvain. Public lectures on history of chemistry are on the other hand offered by the sessions on “Éléments d'Histoire de la Chimie” organised by *Memosciences*, as well as workshops for teachers as part of the general offer for continuing education[14].

At the Katholieke Universiteit Leuven, Geert Vanpaemel teaches a course on 'History of Chemistry', offered for chemistry students as part of their Master programme. This course is optional and counts for 3 ECTS points[15].

The university of Antwerp announced in 2006-2007 an optional course on the history of chemistry (3 ECTS) in the bachelor programme but no teacher is mentioned, nor any programme. Hendrik Deelstra, now retired, has taught history of chemistry and is still in charge of an optional course in the history of officinal drugs and pharmaceutical sciences[16].

At the university of Ghent, a similar optional course History of Chemistry was taught to chemistry students by Dirk Tavernier, now retired, until academic year 2006-2007. The course was also part of the master programme and counted for 3 ECTS points[17]. It might be that the course will be offered again in 2008-09.

At the (Flemish) university of Brussels a course on history of chemistry (3 ECTS) was taught by Gaston Moens, as an optional part of the master programme[18].

History of chemistry is taught at the Science Faculty of the University of Mons Hainaut by Michel Bougard as a part of a master course entitled « Histoire des sciences expérimentales » (History of experimental sciences). Some questions as the chemistry at the end of 18th century, or the opposition between atomists and equivalentists are discussed. The course (2 ECTS) is compulsory for the students who follow a master in chemistry and in physics but optional for the master in mathematics.

At the French speaking University of Bruxelles chemistry students can take a course on History of Science (2 ECTS) during their bachelor years. The course is taught by Pierre Marage, and is offered to all science students.

At Namur, Facultés universitaires Notre-Dame de la Paix, there is an optional course of history of science (2ECTS), offered to all undergraduate science students, and taught by the philosopher Bertrand Hespel. The course mainly consists in a personal paper on a chosen topic, the aim being to find in a historical scientific text the answer to a question the students have themselves rather than to consult secondary literature.

In many cases, the textbooks employed in these courses are W. Brock's *History of Chemistry* and I.Stengers and B. Bensaude-Vincent's *Histoire de la Chimie.*

BULGARIA[19]

The number of the students in Bulgaria is about 250 000. The number of the Higher Education Institutions is more than 100. Chemistry programs are presented in: St. Kliment Ohridski University of Sofia, Paisij Hilendarski University of Plovdiv together with its filials in Smolyan and Kardjaly, Bishop Konstantin Preslavski University of Shumen, Sout-West University in Blagoevgrad, University 'Prof. Dr. Assen Zlatarov' in Bourgas, University of Chemical Technology and Metallurgy in Sofia, University of Food Technologies in Plovdiv.
After adoption the Bologna rules the tendency is to reduce the number of the subjects in the University curricula. Thus the small course on history of chemistry intended for chemistry students of the University of Sofia has been ceased. These lectures were delivered by Mr. Ivan Lilov, former lecturer in the Department of General and Inorganic Chemistry, better known by his popular books in chemistry for children. The lectures included some chronology of the discoveries in chemistry with anecdotes, mythical rather than real, for famous chemists together with a knit of their vignettes. Nowadays, at Bachelor level, no courses in History of Chemistry are presented in the above mentioned universities.

Presently no History of Chemistry teaching is presented in the Bulgarian Master level education with one exception only: the University of Sofia. Faculty of Philosophy, Master of Art Program: Philosophy of Science, History of Chemistry (45 (30+15) h, ECTS: 4. The course is taught by B.V. Toshev.[20] The Syllabus includes four different foci (history of chemical elements, normal science, paradigms of chemistry, chemistry and society) and a "practicum", in which students write small critical reviews of history of science papers. [21]. Another related course entitled 'Philosophy of Science' has recently been introduced in the Graduate Chemistry Curriculum of the Faculty of Chemistry of the University of Sofia. It is an extra course - 30 lecture hours (ECTS 3). The Philosophy of Science is presented on Popper-Kuhn-Lacatos basis and the historical illustrations are from the area of Chemistry. Usually the number of the students is about 20.

A new group on chemistry education and history of chemistry was founded in 2005[22]

CZECH REPUBLIC[23]

Courses on history of chemistry are offered at the Institute of Chemical Technology and the Charles University in Prague.

Miroslav Novak (department of Social Sciences) lectures History of Chemistry at the Institute of Chemical technology in Prague, Czech Republic. The subject is optional for students of all faculties in the second, fourth or sixth semester of bachelor studies. The University was also accredited to give the Eurobachelor degree and, in this case, history of chemistry is compulsory / optional and is lectured in the sixth semester. The course lasts 14 weeks with a 2 hr-lecture weekly.[24]

Vladimir Karpenko (Department of Physical and Macromolecular Chemistry) teaches history of chemistry at the Faculty of Science in the Charles University in Prague. The course is being held in cooperation with the Department of Philosophy and History of Science of this Faculty). It is an independent course included among lectures of the Department of Philosophy and History of Science and it is intended for Bs and Ms students and, in some individual cases, doctoral study as well. It is optional for all students of the Faculty of Science and also for students of the Department of Teaching and Didactics of Chemistry, who are especially recommended to attend it (some years ago it was obligatory to them). The audience is commonly very broad, including students of all scientific fields (chemistry, biology, geology and even geography) and also students from other Faculties (Philosophy), or even from other universities (Technical Univ.). The course on "History of Alchemy and Chemistry" is taught during one semester (15 weeks), 2 hours a week and its main aim is offer a general introductory picture of the development of activities connected with chemistry prior to the end of the 18th century. The main focus is on alchemy and proto-chemistry[25] and a broad list of books are employed.[26]
Apart from these lectures, there are some courses on history of pharmacy.[27]

DENMARK[28]

History of chemistry was taught in University of Aarhus until 2003.[29] Since the fall of 2003 there has been no courses in history of chemistry and it appears that such a course will not arranged for quite a while. There are, however, topics on history of chemistry taught inside other courses. For instance, at the University of Aalborg, there is a course on "Materials: Chemistry and Technology" - Theory and History of Science (2 ECTS[30]). At the University of Copenhagen, the Center for the Philosophy of Nature and Science Studies (CPNSS) offers many courses on philosophy and history of as well a seminar on "science studies"[31]. Moreover, history of chemistry is taught in very small quantities in the secondary school, even if it is not mandatory.

FINLAND[32]

An optional course on history of chemistry (3 ECTS) is offered by the Helsinki University and it is intended for undergraduate students.[33]

FRANCE[34]

The history of chemistry is taught in France in very different institutional contexts: (a) as part of the chemistry studies (b)as part of the curriculum of teachers of science (c) inside doctoral / postgraduate programs on history and philosophy of science (d) as part of courses on other topics (history of medicine and history of pharmacy).

Special courses on history chemistry for chemistry students are taught in the universities of Avignon[35], Angers[36], etc. In other cases, for instance, at the Ecole Nationale Supérieure de Chimie de Montpellier,[37] no special course exists but substantial historical information is taught in specialized chemical courses.

Some courses on history and philosophy of science are compulsory for prospective science teachers. At the University of Lyon 1, there is a Master on « history, philosophy and didactics of science » [38] and a new lecturer Jonathan Simon, whose main area of research is history of chemistry, has recently been hired. At the Ecole Normale Supérieure (Paris), Ludovic Jullien (department of chemistry) organises lectures on history of chemistry delivered by several lecturers [39] .Courses on history and philosophy of science are integrated in the curriculum of science teachers.[40]. A special course is dedicated to different aspects of the history of chemistry. The lectures are given by people coming from different fields and backgrounds. Most are originally chemists (about 75 %) but also historians and philosophers (the list of people changes every year). The course (3 ECTS) is addressed at graduate students as a part of the first year of master (M1) The courses are optional but strongly advised. In fact, most students attend the course. In Orsay the « Groupe d'histoire et difussion des sciences »[41] offers courses on history of science at the Faculy of Science, among them « L3 Chimie – « La matière en questions dans l'histoire » by Virginie Champeau, Nathalie Jas [42].

There are many postgraduate programs on history and philosophy of science and on science studies. At the University of Strassbourg, a center on science and technology studies (Institut de Recherches Interdisciplinaires sur les Sciences et la Technologie) has been recently created. It offers a Master on social studies of science and technology and a European master on Science, Technology and Society. ("Société, Science et Technologie en Europe") [43],[44]. At the University of Lille, the « Centre Commun d'Histoire des Sciences et d'Epistémologie (CCHSE) de Lille 1-CNRS[45], offers several courses on history and philosophy of science, for instance, Bernard Joly, seminaires on « Chimie et mécanisme au tournant du XVIIe et du XVIIIe siècle », or the courses by Rémi Franckowiak, mostly on the philosophy of chemistry At the Centre Koyré and at the University of Paris IX (Nanterre), Bernadette Bensaude-Vincent lectures history and philosophy of chemistry for postgraduate students. Her course on « Philosophie d'une science - Histoire et philosophie de la chimie » (6 credits) offers a discussion the specificies of chemistry among the other sciences and the development of its disciplinary status as a historical process.[46].

In Paris, the Conservatoire des Arts et Métiers offers many courses on history of science and industry, including a course on history of chemical industry by Laurence Lestel.[47] The course « Histoire des objets techniques et produits industriels » is part of the "Master (option recherche) of the Département Economie Gestion, CNAM, Histoire des techniques. It offers a description of

the history of nineteenth and twentieenth-century by focusing on some important industrial products such as acids, fats, dyes, glass, etc.[48]:

In Rouen, Olivier Lafont (Department of Organic chemistry, Faculty of Medicine and Pharmacy) teaches history of chemistry as a part of the course on "general culture" intended for undergraduate pharmaceutical students. There is also a course on history of pharmacy in 4th year of pharmacy.[49] The French society of history of pharmacy is very active and publishes a journal[50]

Apart from these official programs, the "Club d'histoire de la chimie"[51] organizes conferences and meetings on the history of chemistry intended for chemists and the general public [52]

GERMANY[53]

Like in France, history of chemistry is lectured in Germany in many different institutional contexts and intended for diverse audiences: (a) prospective science teachers (b) historians and economists (c) scientists (d) STS programs.

History of chemistry is offered in many programs intended for German prospective teachers of chemistry. The University of Halle - Wittenberg offers a special course on history of chemistry for prospective teachers ("Spezialkurs für Lehramtskandidaten")[54]. A course on the Nobel Laureates on chemistry reviews their life and achievements focussing on the period 1968- 1977[55] In addition, a monthly seminar on history of science and medicine was offered and a course on history of chemistry is offered for chemistry students but open to other science students. [56]. At the Bremen University, a obligatory 3 ECTS course on history of chemistry is offered inside a MA for prospective chemistry teachers[57]. Similar courses lectured at the University of Oldenburg but mostly focussed on history of physics.[58].

At the University of Bielefed, Werner Abelshauser (department of history) lectures topics on history of chemistry and chemical industry inside history of economics and history of science courses.[59]

At the University of Braunschweig, Bettina Wahrig lectures many different courses on history of pharmacy, including topics on history of science. The courses are part of the pharmacy programme with a minor in history of pharmacy and a doctoral program in history of pharmacy.[60]

At the Freiberg Bergakademie, the Center for the History of Science and Technology offers courses on history of technology, environmental history and industrial archaeology, including topics on history of chemistry and chemical industry.[61]

At the University of Hamburg, history of chemistry is taught as a part of history of science courses and seminars for Ms and Ph.D. students.[62]

At the University of Regensburg, courses on history of science (including history of chemistry) are offered at the undergraduate curricula. A new Ms and Ph.D. program on history of science has been recently implemented. The curricula includes courses on "science and society", "history of science", "scientific concepts and classifications", etc. [63]

At the university of Stuttgart, lectures on history of science and technology, including history of science, are offered for undergraduate and Ms students. For instance, inside the program on history of science and technology, a special course (taught by Elisabeth Vaupel) entitled "meat extract, indigo and vanillin" analyses the development of nineteenth-century chemistry and chemical industry.[64] Another course on twentieth century is offered by Otto Krätz.[65] In addition, courses on history of nineteenth and twentieth-century technology commonly include topics on history of chemical industry.[66]

Like other European universities, history of chemistry is taught inside courses on general and specialised chemistry. For instance, at the university of Köln, there is no special course on the history of chemistry but some aspects concerning the history of organic chemistry (Wöhler, Kekule/Cooper, van't Hoff, Fischer, Woodward ...) are taught as part of the main Organic Chemistry classes. And, in some cases, there may be a few specialized (voluntary) lectures on history of chemistry-related topics (for advanced master students, Ph.D. students postdoc and academic staff).[67]

At the Max-Planck Institute (Berlin) seminars and conferences on history of science are held regularly but no official Ms / doctoral program is offered.[68] The Deutsches Museum also organises exhibitions and conference on the history of chemistry. [69] Many other activities (scientific heritage, conferences, publications, etc) are organised by the Fachgruppe Geschichte der Chemie (Gesellschaft Deutscher Chemiker).[70]

GREECE[71]

Athens University offers a postgraduate program on Philosophy and History of Science, including topics on history of chemistry. [72] The Aristotle University of Thessaloniki has two graduate (optional) and 1one postgraduate (obligatory) courses. For instance, the studies in the Schools of Chemistry, which lead to the Degree of Chemistry, last 8 semesters and one of the optional course (2 ECTS) on History and Epistemology of Chemistry (during the first four semesters). Similarly, the University of Ioannina offers a optional course on history of chemistry during the 5th exam.[73]

HUNGARY[74]

Higher education in Hungary starts a big transition to the non-German type universities. Just a small number of courses on history of chemistry have been reported in Hungarian universities:

Eotvos Lorand University of Budapest, Faculty of Science. A course for students of chemistry. Two classes per week, two credit points. The lecturer is an associate professor of department of chemical technology. The course ends with an exam. Textbook: Lorand Balazs: A kémia története (history of chemistry) (Nemzeti Tankönyvkiadó, Budapest, 1996).

Pannon University, Veszprem, the teacher belongs to the department of general and inorganic chemistry, an adjunct professor, chemical engineer, two classes per week, two credit points, exam.

University of Szeged, Faculty of Science. The subject belongs to the department of physical chemistry, two credit points, two classes per week. The subject is optional. Recommended books are the above- mentioned book by Balazs, Thomas Kuhn's book on the structure of scientific revolutions and some titles on the past of Hungarian chemistry. Moreover, in the same University, the applied and environmental chemistry department offers an optional course on the Nobel Laureates in chemistry. 2 classes, two credit points. The lecturer is a professor of the department.

Many courses on general chemistry, organic and inorganic chemistry, etc. contain a section on the history of the subject or the history of some topics. There are some departments of history and philosophy of science and a graduate school of history of science and engineering but no special course on history of chemistry is offered. They organize their subjects around some general and theoretical problems, the historical focus being in physics and, generally speaking, little attention is paid to history of chemistry. The Hungarian Academy of Science has a special committee on history of science but no official Ms or Ph.D. program is associated with this institution.[75]

ITALY[76]

The teaching of the history of chemistry in Italy is mostly connected with courses and programs on history of science. Italian universities have a very large number of courses and permanent positions on history of science (70, of which 34 full professors). Within this group, those who occasionally teach history chemistry courses are Marco Beretta (University of Bologna), Sandra Tugnoli Pattaro (University of Bologna), Antonio Clericuzio (University of Cassino) and Marco Ciardi (University of Bologna). Moreover, some professors (like Ferdinando Abbri and quite many in fact), teach a different discipline (for instance, history of philosophy) but their research interests include the history of science or the history of chemistry.

Special courses on history of chemistry are offered for chemistry students or prospective science teachers. For instance, Luigi Cerruti, who is associate professor of organic chemistry at the University of Turin, mostly lectures history of chemistry[77] and teaches history of science for prospective science teachers[78]. Nicoletta Nicolini and Franco Calascibetta, who are also researchers in chemistry, lecture history of chemistry at the University of Rome.[79]

The University of Florence promotes the storage and enhancement of the chemical laboratory of Ugo Schiff. The Laboratory of Education Research in Chemistry and Integrated Sciences, promoted by the University of Florence, designs a project aiming to transform the old Aula Magna of the Insitute of Chemistry, founded by Hugo Schiff (1834-1915), into a Historic Landscape Foundation, working as a Media Learning Centre on issues related to fundamentals in the history of chemical sciences & technology.

Within the numerous faculties of Cultural Heritage the teaching of chemistry (compulsory) is beginning to be associated with a historical and interdisciplinary research. In this respect are also worth to mention the activities and publications in archeometry and history of chemistry of the *Stazione Sperimentale del Vetro* of Venice[80]

The Italian Chemical Society promotes the publication of a periodical *La Chimica nella scuola* largely devoted to the history of chemistry and chemical education[81]

A society (*Gruppo Nazionale di Storia e Fondamenti della chimica*) gathers professional historians, chemists, teachers and amateurs with some university connections, albeit indirect. The society was founded in May 1986 and organizes national meetings every two years and the publication of their transactions are supported by the *Accademia dei XL*.[82] The *Accademia dei XL* also promotes the enhancement and digital publication of the archives of Italian chemists (Stanislalo Cannizzaro)[83]

The Institute and Museum of History of Science in Florence is engaged in the promotion of conferences and exhibitions related to the history of chemistry as well as in the production of thematic digital libraries on Avogadro, Lavoisier and glass and chemical technology.[84]

At the University Museum in Pavia the collection of instruments by Alessandro Volta has been recently reorganized and in the remaining halls of the museum several important pieces of historical chemical heritage and several didactic and scientific initiatives have been recently taken by the group of history of science of the University headed by Fabio Bevilacqua.[85]

LITHUANIA [86]

According to the regulations of chemical studies in Lithuania the programs have to include some philosophy and history of chemistry.[87] At the University of Vilnius there is an optional course in the department of Chemistry on the History of Chemistry (3 ECTS). In this department there is also a specialisation for chemists working on restoration and conservation of heritage objects. More than 10 students graduated in three years in row and now there is the fourths crop. In Vilniu Pedagogical University Prof. Pranas Buckus (1926-2001) has lectured on the history of chemistry.

At the Kaunas Technological University in Kaunas there is a course on the History of Science intended for Ms and Ph.D. science students, under the supervision of Prof. Juozas Algimantas-Krikštopaitis and Prof. Romualdas Šviedrys. A course on the History of Pharmacy is taught at the Kaunas University of Medicine.

In 1984 J.A.Krikštopaitis have published a book “Clasical Concept of Substance” (in Russian) which is often used as a textbook for history of science and chemistry as well. He also o published a book about outstanding chemist in Lithuania T. Grotthuss. History of chemistry is included in school chemistry textbooks too. In the latest *Chemistry for the VIII classes* (author Rimantas Raudonis). The book includes chapters on Elements of Aristotle, Theory of Phlogiston, History of Mole, How Mendeleev discover Periodical Table, Discovery of Elements, etc.[88].

The Vilnius College of Higher Education organizes conferences for students on the Development of Chemical Technologies and Perspectives. *The Society of History and Philosophy of Science* organises annual conferences *Scientia et Historiae*, the Gediminas Technical University – annual conference on the history of science and techniques. In those events history of chemistry is represented also.

Baltic Associatin of the History and Philosophy of Sciences organizes conferences in all three Republics and publish proceedings “Historiae Scientiarum Baltica”. The latest was the 21st in 2006.

THE NETHERLANDS[89]

The history of chemistry is taught in the Netherlands in many different situations: (a) as a special course for students of chemistry (b) as part of courses on history of science (c) as part of courses on Science, Technology and Society (d) as part of courses on "Academic Competences and Portfolio".

At the University of Utrecht, all first year bachelor students of chemistry have to follow a course in the History of Chemistry during a period of four weeks (1,5 ECTS), taught by Professor Albert P. Philipse. Twelve hours of lectures are given, and the students have to write a short paper. The focus in 2005 was on the history of the concept of Element, and on Lavoisier in particular. [90] A more advanced course, for students of the second or third years, is in preparation. Chemistry students can also follow an optional Minor in the History and Philosophy of Science, with a strong focus on physics. But students who wish to focus on chemistry can do that on an individual basis, supervised by Lodewijk Palm and/or Albert Philipse. In the Master Programme the course book is A.M. Alioto, *A History of Western Science*, which contain hardly any history of chemistry, with the exception of Lavoisier. Some attention is paid to alchemy in the course on Newton. [91]

At Wageningen University and Research Centre (WUR) Lodewijk Palm teaches a course in the History of Science, in which some chemical topics are discussed as well; such as classical and early-modern theories of matter. Modern, 19th and 20th century, chemistry is not covered at all, and neither is chemical technology.

At the University of Groningen there is some teaching on the History of Science, but the History of Chemistry is only marginal within those course(s).

Cees de Pater, at the Free University in Amsterdam, teaches a course in the History of Science (6 ECTS) to students of chemistry and physics, that contains quite some history of chemistry, next to topics such as (the history of) natural philosophy, astronomy, physics, and biology. Professor Frans van Lunteren gives a course on the History of the Earth Sciences, in which two hours are reserved for the history of chemistry (mainly the chemical revolution and some 19th century developments).

At the University of Amsterdam, Chunglin Kwa recently published a good Dutch textbook on the history of science in which some attention is paid to the history of chemistry.[92] All chemistry students at Amsterdam have to follow a course in Chemistry and Society. Until 1993-1994 this course included some history of chemistry (Lavoisier; and twentieth century), but later the attention shifted to topics such as research management. In general, the introduction of the Bachelor/Master structure (Bologna) has been a disaster for the course in Chemistry and Society and in the Philosophy and History of Chemistry. Starting in 2004-2005 though, a new general course was introduced for all science students, which includes the history of science. There is no special focus on the history of chemistry, because the course is open to students of all scientific disciplines.

In the Department of Chemical Engineering and Chemistry of Eindhoven University of Technology, there is a compulsory 3 ECTS unit within the bachelor programme called Academic Competences and Portfolio, which has three topics – one for each of the 3 bachelor years – called History, Methodology and Philosophy respectively. All three topics are focused on

chemistry and chemical engineering, but at the same time pay attention to Science and Technology in general. In addition it should be mentioned that Methodology and Philosophy are also introduced from an historical perspective. The didactical model in each case consists of introductions, discussions in smaller groups, summarized in a plenary session and finalized by an individual assignment: an essay on a chemistry topic of choice including societal and historical aspects (in case of year 1). An annual guest lecture by a speaker from industry is also included, highlighting an industrial process in historical perspective. For part-time students (with an industrial background), a special master program was introduced in 2005 (annual intake around 15 candidates). The program includes a compulsory 4 ECTS unit entitled "Science, Engineering & Society, which consists of compulsory introductions on history of science, history of philosophy of science, history of engineering – all with discussions. In addition there are several term papers with oral presentation, some of which are compulsory on historical aspects. Inspired by all of the above, the Academic Competences and Portfolio will be extended into the new 2-year master program for regular students (as from September 2007), comprising of two units, total 6 ECTS. The Academic Competences part will include components with an essentially historical angle.

At Delft Technical University there is no History of Chemistry proper. As part of a large course of 40 ECTS for students of Mechanical, Martime and Materials Engineering, coordinated by Dr. Joris Dik, some attention is paid to Materials in Art and Archeology (investigation of ancient paints, etc.) and to the 'History of Materials Production and Usage'.

In Maastricht there is no Science Faculty (only Medicine), and therefore there is only research in the history of chemistry (Ernst Homburg; Geert Somsen) within the Faculty of Arts, but no teaching. There are general sources on the Scientific Revolution and on science and technology in the 19th century (Industrial Revolution; Darwin) for first year humanities students. In later years students can choose optional courses on the history of innovations, on the history of visual perception, etc.

NORWAY[93]

There are some courses on history of chemistry at the Norwegian Universities. They cover all the most usual situations in other countries: (a) as part of chemistry curricula (b) intended for prospective teachers of science (c) as part of the history of science courses.

Lise Kvittingen (professor of chemistry education) lectures at the Norwegian University of Science and Technology, Trondheim, Norway, history of chemistry (half a course of 7,5 ECTS) for prospective teachers of chemistry. The course is also open to students with other backgrounds and interests.[94] In addition, Lise Kvittingen and Annette Lykknes and other professors offer an optional course on history of science (7,5 ECTS), which includes one part for chemistry, one for biology and one for physics, then on general part on the history of the sciences and it is intended for Master level.[95]

Rolf Manne, professor of theoretical chemistry at the University of Bergen, lectures an optional course on history of chemistry (10 ECTS) that is part of the chemistry curriculum. The main audience are undergraduate students but it is open to other students.[96]

POLAND[97]

At the Krakow Jagiellonian University, a special course on history of chemistry is taught at the MSc level by Krystyna Łopata (3 ECTS (with exam), 2.5 ECTS (without exam). The course is optional to all the students but obligatory for those who have chosen "chemical education" as a specialization. The lectures are organized chronologically and cover from prehistory to the beginning of twentieth-century with a special section on the development of chemistry in Poland. [98]

At the University of Maria Curie-Sklodowska, an optional course on history of chemistry (1,5 ECTS) is offered[99]. Like in other universities, at the A. Mickiewicz University, Faculty of Chemistry, there is not separate course on history of chemistry but the topic is usually taught (briefly) within the lectures of general, inorganic and organic chemistry.[100]

PORTUGAL[101]

History of chemistry in Portugal is taught in many different contexts: (a) as part of the undergraduate curriculum of chemistry and other sciences (b) as part of the courses in Masters in History and Philosophy of Science (c) as part of general courses on Communication and Education in Science.

At the New University of Lisbon, the recent reform of undergraduate curricula (Bologna process) has eliminated the teaching of history of chemistry and introduced new topics on business studies. The optional course taught by Ana Carneiro at the New university of Lisbon was called “History of Ideas in Chemistry” (4 ECTS (undergraduates); 8 ECTS (post-graduates). The lectures were chronologically organised and it covered from alchemy until twentieth-century with special focus on nineteenth-century. [102] There are also courses about history of science and technology intended for students of chemistry, biochemistry, chemical engineering and informatics. The main teachers are the A.M. Nunes dos Santos, Ana Carneiro, Isabel Amaral, Paula Diogo, and Palmira Costa. Concerning the postgraduate courses (MSc. In History and Philosophy of Science and Technology), the main audience were secondary schools teachers but the number of students fell off during recent years.

At the Technical University of Lisbon, more precisely at one of its schools Instituto Superior Técnico, from 1999 to 2003, one semester of History and Philosophy of Science was part of the undergraduate programme for Chemistry students. In reality the subject of the 30 hours of lectures per semester was History of Chemistry. In addition to the lectures there were presentations by students, in seminar sessions, on specific themes. Professor Bernardo Herold was responsible for the course. After his retirement in 2003, the course was eliminated from the programme.[103]

In the University of Lisbon the History of Chemistry and Physics is included in the Graduate Curriculum of the Chemistry, Biochemistry, Physics and Biology Courses, involving the Centro de História da Universidade de Lisboa, the CICTSUL, the Interdisciplinary Center of Science, Technology and Society of the University of Lisbon. Among the staff are the Professors Ana Simões, José Pedro Sousa Dias, Henrique Leitão, Isabel Serra, Elisa Maia, Ana Luisa Janeira, and Isabel Cruz. This Center also offers a M.Phil Courses in History of Science.

At the University of Évora, there is a Center on the History and Philosophy of Sciences directed by Prof. Augusto José dos Santos Fitas. Other staff members include the Professors Ana Cardoso de Matos, Fatima Nunes, Augusto Franco de Oliveira and Rui Namorado Rosa. They

provide lectures and research in the field of history of science either at the undergraduate and graduate levels.

At the University of Aveiro ,some lectures are given by the Professors Fernando Tomás, Isabel Malaquias and Serrano Pinto in the graduate courses of physics and chemistry. There is a M.Phil course in Communication and Education in Science with some Topics in the History of Science. The Director of that course is Prof. Victor Gil who looks for the participation of collaborators coming from different Departments, both in the Universitty of Aveiro, or from other Universities in Portugal

At the University of Coimbra, there is some interest for the History and Philosophy of Sciences in the Department of Physics, the Department of Chemistry and in the Department of Anthropology, but there are no organised courses on these subjects. In the Faculty of Pharmacy of Coimbra, Prof. J.Rui Pita has a regular course on the history and sociology of pharmacy, and has a research Project in the History of Sciences with Prof. Ana Leonor Pereira, in collaboration with the Research Center on the History of Ideas which belongs to the Faculty of Arts.

RUSSIA[104]

Courses of history of chemistry are taught in Russia in many higher educational establishments and in various contexts. First of all, they are taught at chemical faculties of general educational universities (e.g., Moscow, Saint Petersburg, Kazan' and others) and in higher educational establishments of chemical profile (e.g., Moscow State Academy of Fine Chemical Technology and University of Chemical Technology of Russia). Each of specified educational establishments has its specificity of teaching (see below). Besides, in all higher educational establishments of the country, history of chemistry is now included in general teaching course of subject "History and philosophy of science" for postgraduates specializing in sphere of chemical sciences. This course is usually taught by philosophy teachers. In a number of higher educational establishments lectures on history of chemistry in the context of this course are not read (due to the lack of specialists) and postgraduate students write papers on the history of subject in accordance with specialization chosen by them (e.g., Technical university (MIET), Moscow, Zelenograd).

In the Moscow University[105] at the Chemical Faculty two courses are taught at the moment: [a] "Introduction to history and methodology of chemistry. History of chemical faculty"[106] and [b] "History and methodology of chemistry"[107]. For students who prepare graduation work on the history of chemistry specialized courses on the history of separate chemical disciplines (up to 20 hours) are traditionally given by specialists of history of chemistry sector (T.V.Bogatova, E.A.Zaitseva, O.N.Zefirova). Courses are compulsory, attestation in form of a pass.

In Kazan' university at chemical faculty for students of the fourth year of study there is taught the course "History and methodology of chemistry" by professor G.K.Budnikov and head of museum of Kazan' chemical school[108] (related to the university), T.D.Sorokina. In 2006 they published original study book entitled "History and Methodology of Chemistry in Kazan' University" (Kazan', Kazan' university publishing house) with an aim to improve teaching of this discipline. T.D.Sorokina uses for her lectures exposition and archive materials of museum as illustrative study materials. At the Saint Petersburg University history of chemistry is offered for bachelor students (0,5 ECTS) and master students (1,0 ECTS). The courses are compulsory [109].

In Moscow State Academy of Fine Chemical Technology corresponding courses of "History and methodology of chemistry" are taught to master students specializing in a number of directions (in particular, specialization "chemical technology and biotechnology" (course 77-94 hours) and "science of materials and technology of new materials" (83-101 hours).

Like in many other countries, history of chemistry is taught to prospective chemistry teachers. In University of Chemical Technology of Russia, in connection with the establishment of a pedagogic department (prepares chemistry teachers) with chair of general and inorganic chemistry, there was developed an original curriculum under the direction of head of the chair professor A.F.Vorob'ev. The courses were aimed at preparing chemistry teachers and included a two–semester course on "History and methodology of chemistry", which covered material from natural philosophy studies of ancient Greece and alchemy to chemistry of the end of XIXth century (first semester) and history of chemistry of XXth century (next semester). Because of death several years ago P.M.Zorkii (professor of Moscow university), who read this course, continuity in teaching the course was broken. In the University of Chemical Technology of Russia there is also read a specialized course "History of analytical chemistry" for master students who specialize in "analytical chemistry".
It should be noticed that courses on the history of chemistry taught in Russia commonly include lectures on the following issues: history of chemistry as a part of chemistry and part of culture; fundamental notions of chemistry and their evolution, classification of physical methods of research in chemistry etc.

SLOVENIA[110]

At the Faculty of Chemistry and Chemical Technology. University of Ljubljana, a course on history of chemistry is offered for undergraduate students (7,5 ECTS) and it is obligatory for students of the programme "Chemical Education" (Professional title: Professor of Chemistry)[111]

SPAIN[112]

Graduate, postgraduate and doctoral studies on chemistry are offered in 39 Spanish universities (36 of which belong to the public system). An internet survey reveals that there special courses on history of chemistry (or related topics) in 14 universities (around 1/3 of the total). In most of the cases, the title of the course is "history of chemistry" but other titles are offered : "history of science" (two cases), Chemistry: history and society (University of Alcalá), "history and methodology of chemistry" (Cádiz)., "the evolution of theories and methods of chemistry" (La Laguna). The number of credits ranges from 3 to 6 (that means from 30 to 60 hours / lectures) but most of the cases are 4,5 credits (45 hours). The new ECTS has not been implemented in many cases, just some pilot groups. The courses are usually offered during the first three years of the curricula but, in some few cases, history of chemistry is also offered for postgraduate students (at the end of the chemistry studies). Lecturers are mostly chemists (who also taught other courses on chemistry) and also an increasing number of historians of science (who also taught other courses on history of science and technology). The content of the courses is very diverse but many courses are organized in a chronological sequence. Other courses include a thematic approach (science and industry, professions, institutions, scientific practices, etc.). There are a substantial group of textbooks on history of chemistry, not only translations (Bernadette Bensaude-Vincent / I. Stengers; William Brock's History of chemistry) but also textbooks written by Spanish authors:[113]

Courses on “history of chemistry” intended for students of chemistry during the first years (undergraduate level) are offered by the university of A Coruña (30 hours)[114], Barcelona (Universitat Autònoma de Barcelona) (45 hours),[115] Castellón (Jaume I) (45 hours), La Laguna (45 hours) [116] Madrid (Universidad Complutense) (45 hours)[117] , Málaga (45 hours), [118] Murcia (45 hours), La Rioja (30 hours),[119] Valencia (45 hours) [120] . At the University of Cádiz, a course on “history and methodology of chemistry” (60 hours) is offered[121] while at the university of Alcalá the course (60 hours) is entitled “chemistry: history and society”. [122] Some universities (“Ramon Llull” (Barcelona), Tarragona, Zaragoza, etc.) offer courses on history of science, in which topics on history of chemistry are included. Most of the Spanish universities offer special courses on history of pharmacy.

At the Universitat Autònoma de Barcelona, a new master on history of science has been organised during the last years and it includes a course on history of chemistry [123] A few group of Spanish universities offer doctoral programs on history of science but the situation will change during the next years due to the reform of curricula (Bologna process).

SWEDEN[124]

In Sweden, history of chemistry (like other disciplinary histories) is hardly taught as a separate course but it is integrated in the lectures and courses organised by the departments of History of Science and Ideas.

All major Swedish universities (Uppsala, Stockhjolm, Gothenburg, Lund, Umeå.) have departments for History of Science and Ideas (or, which comes to the same thing, Department of History of Ideas) and history of science is a considerable part of the basic courses at these departments, and chemistry gets its share of it, although, unfortunately, not to the same extent as the more "philosophical" discipline of physics, or the more spectacular discipline of biology. I should estimate that 1-2 hours is dedicated to chemistry during a term course at the bachelor degree. A complete course is a usually one-term course (equivalent to 30 ECTS credits). The main audience are students of history and some students of science. How much is dedicated to history of chemistry is hard to say, but it is not too much. There are no special textbooks in history chemistry, more than is included in general overviews (the situation is the same for the other disciplines).[125]

During second term and on higher levels, sometimes courses are given with titles like "Science and religion", "Science and technology" and the like, were also chemistry can be find as part of a bigger parcel. Usually, these courses are not overview courses, but rather problem-oriented courses, i.e., case studies from the history of science are employed to highlight the role of science in society, its relation to religion, politics etc. Examples from the history of chemistry are here more frequent, even if biology, and especially physics and technology still dominate. However, these courses are important, because through them a contact is established between historians and scientists in a very promising manner.

At the Uppsala University, courses on history of science are offered for students of philosophy and students of science. There are no independent courses on history of chemistry, but the topic is included in general course on history of science, even if the place for chemistry in these courses is relatively small.[126] An “office for the History of Science” is organised under the department of Science and Ideas and group publishes a journal (*Lychnos*) and a newsletter, which offers additional and updated information about courses, conferences, etc.[127]

At the Lund University, an annual course on history of chemistry is offered at the basic level but most students following the course have at least completed their basic level chemistry courses.- The course (7,5 ECTS) is optional but the credits can be included in the degree as part of the optional credits. [128]

In the curricula of civil engineering, there is a course on"System in Technology and Science", in which quite a lot of history of science is included.

UNITED KINGDOM[129]

There are no special courses on history of chemistry courses as an integral part of a chemistry degree course. A few universities (Oxford, Cambridge, etc) offer optional history of science courses as part of the science curriculum. For instance, at the university of Durham, Chemistry students take 4 modules of chemistry at level 1, and 6 modules (approximately 10 ECTS) of chemistry at levels 2, 3 and 4. None of these chemistry modules contains any history of chemistry but level 1 students take 2 modules outside the defined chemistry modules and they are able to choose from a wide range, including philosophy of science[130] and history of scientific thought[131], which includes some topics related to history of chemistry. [132]

Probably the biggest single output of the history of chemistry in this country is the Part II thesis, which is the fourth year of the Oxford chemistry degree, [133]

Several universities which offer history of science degrees at the first (Bachelors) and/or second (Masters) level and nearly all of them will have some history of chemistry in them. Students can of course take PhDs in the history of chemistry, and a few do (but on average it would be less than one a year across the UK).

Public lectures and conferences on a broad range of topics related to history of chemistry are regularly organised by the Historical Group of the Royal Society of Chemistry[134] and the Society for the History of Alchemy and Chemistry.[135]

PRELIMINARY CONCLUSIONS

1.- History of chemistry is taught as separate course in three main institutional contexts (a) as part of the Scientific / Chemistry curricula (optional and aimed at undergraduate students in many cases) (b) As part of the prospective teachers curricula (obligatory in many cases) (c) In programs (Masters in many cases) on History and Philosophy of Science; History of Science, Technology and Medicine (UK) or Science, Technology and Society, etc.

2.- Other institutional spaces play a minor role : (a) It is surprising the small presence in humanities programs: history (Germany) and philosophy (France, Bulgaria) (b) Mining schools (business departments) (c) Public lectures (more or less related to groups, doctoral programs, etc.) (Koyré center, Paris; Memosciences (Belgium), Royal Society of Chemistry (UK) (d) Associated with other areas – History of pharmacy: Braunschweig, Germany; Rouen (France), Coimbra (Portugal), Spain, etc; (e) Studies on scientific communication / scientific journalism (Aveiro, Master in Communication and Education in Science; Turín, Foundations of Chemistry for "Scientific Communication"). Courses on philosophy of science usually are focussed on physics and biology, not in chemistry.

3.-History of chemistry as a part of chemistry / scientific curricula. In almost all the European countries, there are at least some universities whose chemistry curriculum includes courses on history of chemistry. It is usually an optional course integrated in bachelor (but also for Master) curricula. It is generally taught by chemists by training (who usually also taught other courses on chemistry. The number of credits is usually between 3 and 5. For instance: (Avignon, France (3 ECTS); Sweden (Lund University, opt. 7,5 ECTS); Finland (Helsinki, 3 ECTS; Bergen, 20 ECTS both graduate but mostly undergraduate); The Netherlands (Utrecht, 1,5 ECTS; Amsterdam (but now "Chemistry and Society"); Wien (Austria; 3 ECTS for Chemical Engineering); Hungary (Univ of Budapest, around 2 ECTS, etc. The presence of History of Chemistry in Masters (postgraduate) of science / or chemistry is scarce but there are some examples, for instance, in Italy, the Master on Material Sciences, Turin, or in the master on Analytical Chemistry at the Russian University of Chemical Technology. Most of the courses are optional courses but in a handful of cases, they are obligatory, mostly for students who want to became teachers of chemistry.

4.- There are no separate / special courses of history of chemistry in the faculties of science in many European universities. No reliable statistical data is available, apart from Spain (1/3 Spanish universities offer special (generally optional) courses on history of chemistry. In an informal survey of 60 cases, just 17 answers were positive, that is, that separate courses on history of chemistry were taught as part of the chemistry CV. However, in many cases, substantial historical information is provided in lectures on general chemistry, both in introductory and advanced courses. The available information suggests that history of chemistry is an unknown topic for many humanities students, including students of history (little information in textbooks on general history, no course on history of science in many faculties of history).[136]

5.- In many cases (particularly, in Italy, Netherdlands, Sweeden and United Kingdom), history of chemistry is integrated in courses on history of science. Chemistry students can follow courses on history of science, in which topics related to history of chemistry are discussed. The title of these courses is generally "history of science" but also "theory of science" (University of Copenhagen, Denmark).

6.- History of chemistry is also offered as a special course for prospective teachers of science. And, as said before, in many cases as an obligatory course. For instance, in Slovenia, at the Faculty of Chemistry and Chemical Technology. University of Ljubljana, the course on history of chemistry is offered for undergraduate students (7,5 ECTS) and it is obligatory for students of the programme "Chemical Education" A similar situation happens in many other universities in Germany, Czech Republic, France (Lyon 1, ENS, Orsay), Germany (Halle, Bremen), Italy (Turin), Norway (Trondheim), Russia (University of Chemical Technology) or Poland (Krakov). In many other countries, history of science is regarded as complementary but important topic for the training of future teachers of science.

7.- History of chemistry topics are a substantial part of other formative activities such as undergraduate thesis (Oxford) or "Diplomarbeiten" (Austria).

8.- History of chemistry is also part of the new Masters on History and Philosophy of Science, either as a separate course or as topics integrated in larger history of science courses. There are many examples in countries such as Portugal (Master Phil. in History of Science, Lisboa); Italy (University of Bologna; included in history of Philosophy courses); Norway (Norwegian University of Science and Tecnology, master on history of Science); Germany (to be started in 2006, Master in History of Science, Regensburg); Spain (Universitat Autònoma de Barcelona, master on history of science); Greece (master on Philosophy and History of Science, Athens); And many different masters on history of Science, Technology and Medicine that are held in British Universities. History of chemistry is also taught in Masters focussed on history of technology (CNAM, France); Science, Technology and Society (Strassbourg, France; Bielefed, Germany Stuttgart, at the Faculty of History). In a few cases, undergraduate students can obtain a Minor on History and Philosophy of Science (Utrecht, University).

9.- Who is teaching history of chemistry? No reliable statistical data is available but it seems that there are scarce number only a few permanent positions for historians of chemistry. In many cases, (particularly in Faculties of Sciences / Chemistry), history of chemistry is taught by teachers / professors who also taught other topics. Their positions are associated with the "scientific topics" they taught, not with the history of science topics. Therefore, in many cases, courses on history of chemistry are cancelled when the responsible professor was retired. In most of cases, the teachers of history of chemistry are chemists (working in other departments of chemistry). There is also a large group of historians, philosophers, etc. (whose research is focused on history of science or related topics) as well as chemistry educators (whose research is focused in chemical education topics). In some countries (France, Italy, Sweden, Holland, UK, etc.), there are departments of history and philosophy of science with permanent positions and facilities for teaching and research in history and philosophy of science. In that case, the teaching of history of chemistry largely depends on the scientific interests of professor and it is worth noting that historians of chemistry are just a very small part of the large community of historians of science.

10.- The contents and structure of the courses on history of chemistry are very diverse. That is not surprising at all when taking into account the diverse institutional contexts and curricula, the different intended audiences and the broad range of teachers' research interests and backgrounds. Many courses (specially those taught by chemists and intended for chemistry students) are structured in a chronological order and focussed on the history of concepts and

ideas in chemistry. The focus is nineteenth and twentieth-century chemistry and, just in some cases, alchemy and early chemistry is discussed in depth. Just a few group of courses deal with topics such as science and society, science and religion, gender studies, professions, laboratory life, etc. These topics are discussed mostly in courses on general history of science, generally taught by professional historians of science. There are some courses on "Nobel laureates on chemistry" and other topics related to history of chemistry. Concerning textbooks, the most popular textbooks are employed the general history chemistry written by Bernadette Bensaude-Vincent and Isabelle Stengers[137] and William Brock[138] (which are available in many European languages) and also the most recent book by Trevor Levere (*Transforming Matter*)[139]. Other books such as Hudson's history of chemistry are also employed in some universities (Spain, Norway)[140]. There are also textbooks on history of chemistry, which are written in local languages.

12. - Web page facilities. Just a very small number of curricula and internet resources are available at web pages. There is a lot of work to be done.

13.- The impact of the reform of University curricula. In some cases, the impact of the Bologna reform is reported to be negative in some cases, at least at the undergraduate level. For instance, in Lisbon (Portugal) the course (4 ECTS) ceased to be taught because curricula reform. Some other courses have disappeared during the last years in Bulgarian and Danish universities. [141] However, new programs for BA – Chemistry (such as Eurobachelor) included in their intended outcomes skills, competences and abilities that can be developed by the study of history of chemistry: terminology, problem solving, scientific writing, information-management, interpretation of experimental data, ability to adapt to new situations, communication competences, ethical commitment, scientific reasoning, ability to use with scientific concepts, etc.[142] Even if not included in the compulsory courses, Eurobachelor program suggests at large number of modules freely allocable by the local universities, in which history of chemistry / history of science can be reasonably included. The consequences of the reform seems to be very positive at the Postgraduate level (Master), Generally integrated in History and Philosophy of Science courses; Chemical education: Many new Masters on History and Philosophy of Science have been created or will start during the next years: Norway (Norwegian University of Science and Tecnology, master on history of Science, to be started in 2006); Germany (to be started in 2006, Master in History of Science, Regensburg); Spain (Barcelona, Master on history of Science, started in 2006), etc. Summing up, courses on history of chemistry (or history of science) for students of chemistry could disappear in the next few years due to the current reform of many university curricula.

14.- The activity of chemical societies is very important in supporting activities related to history of chemistry in many European countries: supporting meetings (on history of chemistry, chemical heritage), journals (Germany, Bulgaria), newsletters, working parties, chemical heritage (Germany), books (Royal Society of Chemistry). The report shows that the national and European Chemical Societies can largely support the implementation of courses on history of chemistry in the curriculum of future chemist.

NOTES

[1] http://www.euchems.org/Divisions/History/index.asp

[2] Please send your comments, amendments and suggestions to bertomeu@uv.es. I would like to thank all the contributors to this report for their information, help and support. I am particularly grateful to Evangelia Varella, who started the project, Ernst Homburg, who has gathered a lot of information and coordinate the last revisions, and Duncan Burns who kindly revised the language of the final draft versions.

[3] BERETTA, M. (1992), The historiography of chemistry in the Eighteenth Century: a Preliminary survey and bibliography, *Ambix*, *39* (1), 1-11. CHRISTIE, J.R.R. (1994), Historiography of chemistry in the Eighteenth century: Herman Boerhaave and William Cullen, *Ambix*, *41* (1), 4-19.

[4] KOPP, H.F.M. (1843-47), *Geschichte der Chemie*, Brunswick, F. Vieweg und Sohn, 4 vols.

[5]. ROCKE, A. (1994), History and Science, History of Science: Adolphe Wurtz and the Renovation of the Academic Professions in France, *Ambix*, *41* (1), 20-33.

[6] RUSSELL, C.A. (1988), Rude and Disgraceful Beginnings: A View of History of Chemistry from the Nineteenth Century, *British Journal for the History of Science*, *21*, 273-294.

[7] For more details on the historiography of chemistry, se WEYER, J. (1974), *Chemiegeschichtesschereibung von Wiegleb (1790) bis Partington (1970). Eine Untersuchung über ihre Methode, Prinzipien und Ziele, Hildesheim,* Verlag Dr. H.A. Gertengerg. For the recent developments, see RUSSELL, C.(ed.) (1985), *Recent developments in the history of chemistry*, London, Royal Society of Chemistry, 333 p; ROBERTS, G.K.; RUSELL, C.A. (eds.) (2006), *Chemical History: Reviews of the Recent Literature*, London, Royal Society of Chemistry.

[8] For an introduction to this literature, see MATTHEWS, M.R. (1994), *Science teaching: The role of history and philosophy of science*, New York, Routledge, 284 p. And the journal *Science & Education*.

[9] For former reports, see KAUFFMAN, G.(ed.) (1971), *Teaching the History of Chemistry*, Budapest, Akadémiai Kiadó. On USA, see EVERET, K.G.; DE LOACH, W.S. (1987), Who is teaching the history of chemistry?, *Journal of Chemical Education*, *64*, 991-993. For a very fruitful discussion of the methods and purposes of teaching history of science, see SHORTLAND, M.; WARWICK, A. (eds.) (1989), *Teaching the History of Science*, Oxford, Basil Blackwell. For a recent review of English-American textbooks on history of chemistry, see W.B. Jensen, Textbooks and the Future of the History of Chemistry as an Academic Discipline, *Bulletin for the History of Chemistry 31* (1), (2006), 1-9.

[10] Part of the information by was kindly provided by Peter Gaertner

[11] http://info.tuwien.ac.at/struchem/mitarbeiter/soukup.htm

[12] http://info.tuwien.ac.at/dektnf/Download/TCH_StudienplanUniStG.pdf

http://tuwis.tuwien.ac.at/zope/_ZopeId/35620532A2BJ1xwPCcw/tpp/lv/lv/inst/InstLvas?nr=164

[13] Part of the information was kindly offered by Michel Bougard, Brigitte van Tiggelen and Geert Vanpaemel.
[14] See http://www.memosciences.be/index.htm.
[15] The course is based on chapters from several textbooks, such as W. Brock, The Fontana History of Chemistry and Bernadette Bensaude-Vincent and Isabelle Stengers, A History of Chemistry.
[16] Hendrik Deelstra has taught during 30 years a 20 hours optional course using mainly Ihde's. Between 2003 and 2007, this course was merged in 2003 as a part of a more general course on the history of natural and medical sciences in the curriculum for teacher education with other a course in the history of science. Since R. Van Hee, actually in charge, will soon retire, the future of this course is actually uncertain.
[17] The course is based on Brock's History and on H. Kubbinga, De Molecularisering van het Wereldbeeld [The Molecularization of the World Picture]. Tavernier is a recently retired professor of chemistry.

[18] Moens also uses Brock as the basic textbook for his course.

[19] Information provided by Borislav Toshev.

[20] The lector is Prof. B.V. Toshev, Research Laboratory on Chemistry Education and History and Philosophy of Chemistry, Department of Physical Chemistry, University of Sofia, E-Mail: toshev@chem.uni-sofia.bg.

[21] Summary: I. History of Chemical Elements (periodization in Chemistry: antiquity, alchemy, XVII and XVIII centuries, classical chemistry, modern chemistry). Chemical substances of importance for the human civilization: water, carbon dioxide, NaCl, bases and acids, metals and alloys, ammonia. Names reactions in organic chemistry as an illustration of the advancement of chemistry. II. The normal science and its paradigms (Kuhn). History of science and its rational reconstructions: the rational reconstruction as a key for understanding the real history (Lacatos). III. The paradigms of chemistry: a) Discovery of oxygen by Lavoisier; b) D.I. Mendeleev and the periodic law; c) J.W. Gibbs and the chemical thermodynamics. IV. Chemistry and society: Direction of processes in Nature (H-theorem of Boltzmann); direction of processes in society (R.W. Emerson); fluctuations: the blue sky; Brownian movement; nucleation. The practicum (in small groups) is aimed to the development of skills of the students for written and oral scientific communication by critical reviews of papers from scholarly journals in the field of history and philosophy of science (e.g. Ambix, BJHS, Isis, Hyle, Foundations of Chemistry, Notes and Records of the Royal Society, etc.). The sudents study social sciences: philosophy, psychology, education, etc. and their background is NOT chemistry.

[22] TOSHEV, B.V. (2006), A New Society in Bulgaria Links Hard and Soft Science with Education. Birth of the Bulgarian Society for the Chemistry Education and History and Philosophy of Chemistry, *History of Science Society Newsletter*, *July*, p. 19.

[23] The information was kindly provided by Jana Copikova, Vladimir Karpenko, Miroslav Novak and Sona Strbanova.

[24] The syllabus (in Czech language): http://www.hned.cz/vscht/main.php. 1. Significance of chemistry and its role in history of human society. Parallel development of theoretical and applied chemistry. 2. Important centers of ancient society development. Ancient chemical and technological knowledge. Metallurgy, pottery, glass, dying, fur dressing, detergents, *etc.* 3. Alchemy, its role in chemistry evolution. Theoretical resources of Hellenistic-Arabian alchemy: tetrasomial theory, sulfur-mercury theory, *lapis philosophorum*, *aqua vitae*. Hellenistic alchemy, Arabian alchemy, European mediaeval alchemy, alchemy in the Czech lands. Alchemy in other parts of the world. Notable alchemists and alchemical writings. 4. Practical aspects of alchemy - systems of alchemical substances, equipment of alchemical laboratories, alchemical techniques. 5. Transient period. Iatrochemistry, pneumatic chemistry, flogiston theory. 6. Renaissance, enlightenment and origins of modern chemistry. Chemical revolution - Lavoisier and disciples. 7. Development of ideas on chemical composition of matter. Quantitative laws of chemical reactions. 8. Beginnings of the atomic theory. Problem of atomic weights in the 19th century. Dualistic and unitary system, type theory. Periodization of elements. 8. Modern development of the atomic theory. Discovery of radioactivity, development of quantum mechanics, theory of chemical bond. 9. Development of analytical chemistry. Medieval docimacy. Qualitative and quantitative analysis. Instrumental analytical methods. 10.Historical development of theoretical views in organic chemistry. Etherin, radical, substitution, type, structural theories. Theory of aromatic compounds, structure of benzene core. Stereochemistry. 11.History of applied chemistry I. Metallurgy, petrochemistry, pharmaceutical chemistry, polymers, china. 12.History of applied chemistry II. Saltpeter and powder, alum, vitriols, soda, potash, sulfuric acid, fertilizers, lighting gas, sugar industry. 13.Development of chemical nomenclature. Alchemical nomenclature. Development of scientific nomenclature - Lavoisier, Dalton, Berzelius. Modern nomenclature - Geneva nomenclature, IUPAC. Development of Czech nomenclature - Presl, Šafařík, Votoček. 14.History of teaching of chemistry in the Czech lands. University and technical educational systems. History of the Institute of Chemical Technology in Prague. Notable personalities in ICT. Nobel Prizes in Chemistry. Jaroslav Heyrovský.

[25] (C260P41C, C260P41K, C260P41U, C260P41Z) Sylllabus: Problem of sources and of their interpretation. Crafts in the ancient world: salt production; dyes and paints. Cosmetics. Wine and beer. Discovery of paper. Mummification in Egypt; history of the term neter. Sumerian terminology. Myths as the oldest explanation of natural phenomena. Mother-Earth, “birth” of metals. Seven ancient metals and their metallurgy. Precious metals. History of gold. Silver, cupellation. Analysis of precious metals, destructive and nondestructive methods. Ancient China. Confucianism and taoism. Five phases, their mutual transformations and relation; jin-jang. Magic square

Lo shu and eight trigrams. I Ching. General history of Chinese alchemy. The book Chuai-nan tzu. Wej Po-yang and his Tsan Tung Chi. Ko Hung's work. Chinese protochemistry. Discovery of black gunpowder. India. Harappan civilization. Vedas and upanishads. Problem of dating Indian literature. Theories in Indian science; five elements, atomism. Attempts at classification of different substances. Tantric origin of Indian alchemy. Practice in Indian alchemy; mercury and sulfur; Shiva and Parvati. Examples of alchemical texts. Hellenistic world. Greek natural philosophy; Aristotle; four elements. Egyptian crafts: papyri Leyden X and Stockholm. Possible origin of hellenistic alchemy: crafts, gnosis - ouroboros, astrology - deification of planets; planets and metals. Pseudodemokritos. Zosimos, his Vision. Mary the Jewess. Laboratory instruments and techniques. Color symbolism. Arabic alchemy. An-Nadim and his catalogue. Sufism. Jabir and his school; sulphur-mercury theory. Numerical mysticism in Arabic alchemy and philosophy. Ar-Razi and his system of the known substances. Brethren of Purity and their view of the origin of metals. Avicenna, Kitab as-shifa and its influence. Europe. Crafts in Middle Ages. Theophilus; Mappae clavicula. History of alcohol. The origin of alchemy in Latin Europe. Albertus Magnus and his work. Pseudoarnald. Lully and Pseudolully. Pseudorhazes. Pseudogeber and roots of corpuscular views; discovery of strong mineral acids. Alchemy and church. Renaissance. General features, development of astronomy and medicine: Copernicus and Vesalius. Mining and metallurgy: V. Biringuccio, L. Ercker, G. Agricola. Paracelsus and his tria prima; homunculus; basic information about Jewish cabbala. Mysticism: Agrippa of Nettesheim. Alchemy in Bohemia. Johannes Ticinensis. Johann of Laz and his work. Hynek of Podebrad. Rudolfian epoch: Bavor the Younger Rodovsky of Hustirany. J. Dee and E. Kelley. M. Sendivogius, M. Maier, and D. Stolcius, their life and work. Symbolism in renaissance alchemy. R. Boyle and I. Newton as alchemists. Discovery of phosphorus. J. Becher and phlogiston. Summary of European alchemy: chemical and metallurgical techniques of the alleged transmutation. History of the redox reaction between cupric ions and iron; the influnce of this reaction on alchemical speculations. Transition between alchemy and chemistry. Pneumatic chemistry. A.-L. Lavoisier, life and work. Development of chemical symbolism and nomenclature. First discoveries of elements.

[26] The books included translations such as Eliade, M.: *Kováři a alchymisté*, Praha, 2000 (Czech translation of *Forge and the Crucible*); Engels, S., Nowak, A.: *Chemické prvky. Historie a současnost*, Praha, 1977 (*Chemical elements*, transl. from german).; Gebelein, H.: *Alchymie. Magie hmoty*, Volvox Globator, 1998 (Transl. From German); Priesner, C., Figala, K. (editoři): *Lexikon alchymie a hermetických věd*, Praha, 2006. (Czech edition of *Lexikon*) and original books such as Karpenko, V., Augusta, P.: *Křivolaké cesty vědy*, Praha, 1987 (*Tortuous Ways of Science*); Karpenko, V.: *Alchymie – dcera omylu*, Praha, 1988 (*Alchemy – Daugther of Error*); Karpenko, V.: *Tajemství magických čtverců*, Praha, 1997 (*The Secret of Magic Squares*); Zýka, J., Karpenko, V.: *Prvky očima minulosti*, Praha, 1984 (*Elements through the eyes of the past*), etc.

[27] PhDr. Karel Král, Associate Professor (until August 1, 2006), and
after August 1, PhDr. František Dohnal, Assoc. Prof., Ladislava Valášková , MSc., teach history of pharmacy in Hradec Králové Pharmaceutical Faculty (Charles University)
[28] Information was kindly provided by Anja Skaar Jacobsen and Anita Kildebæk Nielsen.
[29]For details about the course see:
http://www.ivh.au.dk/kurser/e03/aspekter_af_de_kemiske_videnskabers_historie.dk.html. The lecturers were Anita Kildebæk Nielsen and Anja Skaar Jacobsen.
[30] The course is taught by Kristian Keiding, Yuanzheng Yue, Kim Lambert Larsen and Donghong Du

[31] See http://www.nbi.dk/natphil/ . On the studies on history of medicine, see SIGNILD VALLGÅRDA, The History of Medicine in Denmark, *Social History of Medicine*, 1995 8(1):117-123.
[32] Information kindly provided by Nina Aremo.

[33] http://www.helsinki.fi/kemia/english/

[34] Part of the information was kindly provided by Sacha Tomic, Olivier Lafont, Ludovic Jullien, Laurence Lestel, Gerard Bauduin and Cathy Vieillescazes.
[35] - L1, second semester – Optional course, 3 ECTS [Histoire des sciences for students of chemistry]. Information provided by Cathy Vieillescazes. See http://www.sco.univ-avignon.fr/forma_fiche.html#domL3STE and http://www.sco.univ-avignon.fr/forma_parc.html?testuapv=&mentchoix=CPAI&dipchoix=L3PH&typelmdchoix=L&parcchoix=LPCHIPHY&annee=1&semestre=2
[36] See http://www.univ-angers.fr/latos.asp?ID=101&langue=1. The teacher is *David Rondeau (*Ingénieur de Recherche, Instrumentation Scientifique, - spectrométrie de Masse.
[37] http://www.enscm.fr/

[38] http://offre-de-formations.univ-lyon1.fr/visu_mention.asp?puk=41

[39] http://www.chimie.ens.fr/lmsmo/W3lmsmo.html
[40] For instance, in 2006, the lectures on « *Histoires de la chimie. »* were held in ENS, Paris during 15th and 16th May, 2006. The lectures were delivered by J.-B. Baudin (ENS), Virginie Champeau (Paris XI), Ludovic Jullien (ENS), Laurence Lestel (CNAM), Clotilde Policar (Paris XI),… The intended audiences were « Enseignants des premiers cycles : CPGE (BCPST, PC, PCSI, Véto), BTS, IUT ». The main purpose is described as follows: « L'histoire des sciences est essentiellement absente de l'enseignement au niveau du premier cycle universitaire. De nombreux enseignants estiment pourtant qu'elle devrait représenter une part significative de l'apprentissage des fondamentaux disciplinaires. Il ne s'agit pas simplement de captiver tel auditoire par une anecdote pittoresque. Il en va plutôt de la contextualisation des connaissances dispensées, autant pour apprécier la valeur des travaux du passé que pour déterminer les activités signifiantes du futur. La chimie offre des entrées historiques nombreuses qu'il est possible d'investir dès le premier cycle universitaire. C'est ce que propose d'illustrer ce stage de formation au travers de quatre axes de lecture : i) Rupture au XVIIIème siècle : L'expérience comme dialogue avec la matière réactive ; ii) Far West chimique au XIXème siècle : De la naissance des atomes et des molécules ; iii) La matière chimique : représentations et interprétations du réel au cours de l'histoire ; iv) Chimie et Techniques de caractérisation : 200 ans d'histoire commune. Un atelier sera par ailleurs consacré aux sources bibliographiques avec une présentation d'ouvrages et de pages Web (en particulier, accès au fond de la Bibliothèque National de France par Gallica). Une demi-journée sera par ailleurs consacrée à des visites de sites d'intérêt historique au cours de ce stage »

[41] (http://www.ghdso.u-psud.fr/enseign.htm); http://www.u-psud.fr/Orsay/default.nsf/Page/GHDSO

[42] Danielle Fauque, whose main area of research is the history of chemistry, is part of this group. The course on « La matière en questions dans l'histoire » was coordinated by Virginie Champeau. The topics include « la science grecque : la place de la matière dans les conceptions du monde » « la matière et la chimie « « Des origines de la chimie : artisans, alchimistes...; » » Des métaux aux « airs » : une période charnière XVII-XVIIIe siècles » »Autres points de vue sur la matière » »Histoires d'atomes 19-20e siècle (de la chimie à la physique) » »Comment penser l'animé et l'inanimé entre chimie et sciences du vivant ? « Parcours : optionnel : parcours : chimie, chimie physique, matériaux - S6.

[43] http://irist.u-strasbg.fr/index.php?option=com_content&task=view&id=5&Itemid=6
[44] http://www.esst.uio.no/master/curriculum.html
[45] http://www.univ-lille1.fr/cchse/. Associated to the UMR « Savoirs et Textes » (CNRS Lille 1 - Lille 3) –
[46] Pré requis : Le cours ne requiert pas de formation scientifique mais il exige une lecture préalable d'un ou deux ouvrages généraux sur l'histoire de la chimie. Contenu : Le cours déploie trois approches ou perspectives sur la culture chimique.
- Approche épistémologique : dégager les méthodes d'administration de la preuve, les rapports entre théorie et expérience, les rapports entre science et technique.
- Approche philosophie de la matière : dégager les concepts de base autour desquels s'articule la philosophie de la matière propre aux chimistes : leur évolution et leur statut ontologique.
- Approche anthropologique : rapports nature/artifice ; image publique de la chimie, modes de production du savoir ; gestion des risques et accidents ; questionnements éthiques.
Répartition horaire : De 30 à 35h
[47] http://www.cnam.fr/cdht/seminaire_c2.html: Topics : Les grandes étapes de l'histoire de la chimie du XIXe et XXe siècles ; Chimie antique et alchimie, Les débuts de la chimie moderne, Histoire de la nomenclature chimique, Les modes de représentation de l'objet chimique, Mendeleïv et la classification périodique des éléments, L'essor des produits industriels, Acide sulfurique : « le baromètre de l'activité industrielle », L'industrie sucrière, Des corps gras de Chevreul aux détergents modernes, L'art de la teinture et de l'impression sur étoffe, Les matières colorantes de synthèse, Naissance du génie chimique, Chimie et électricité, Le défi des gaz industriels, Les engrais artificiels, Naissance de l'industrie des matières plastiques, Les verres : fusion et chimie douce, Des colles traditionnelles au collage structural, La chimie des combustibles, De l'assainissement industriel à la chimie verte
Bibliographie : F. AFTALION, Histoire de la chimie, Paris, Masson, 1988. B. BENSAUDE-VINCENT et I. STENGERS, Histoire de la chimie, Paris, La Découverte, 1993. B. VIDAL, Histoire de la chimie, Paris, PUF, Coll Que sais-je ?, n°35, 1998, 2ème éd. B. WOJTKOWIAK, Histoire de la chimie, Lavoisier, Tec et doc., 1988, 2ème éd.

[48] L'essor des produits industriels : Acide sulfurique : "le baromètre de l'activité industrielle" - Des corps gras de Chevreul aux détergents modernes - L'art de la teinture et de l'impression sur étoffe - Les matières colorantes de synthèse - Naissance du génie chimique - Chimie et électricité - Le défi des gaz industriels - Les engrais artificiels -

Naissance de l'industrie des matières plastiques - Les verres : fusion et chimie douce - La chimie des combustibles - De l'assainissement industriel à la chimie verte.
cf.
http://dnf2.cnam.fr/offre2005/ue.php?code_formation=HTC217&spe_dem=S16&pole_dem=P1&de=list_ues.php

[49] The analysed topics are: *The myth of Prometheus and the discovery of fire. *Greek philosophers and their influence on chemical theories.*Alchemy and the emergence of experiments.*Paracelsus and iatrochemistry. *Strengthening of knowledge and the triumph of reason: XVIIth century. J.B.Van Helmont, Jean Rey, Robert Boyle, Nicaise Lefebvre, Christophle Glazer,Nicolas Lemery,*Geoffroy and his "affinities table".*Phlogiston or elementary fire "à l'époque des Lumières"*Pneumatic chemistry or the contribution of northern countries: Joseph Black, Henry Cavendish, Joseph Priestley, Carl-Wlhelm Scheele..*Lavoisier and the chemical revolution or the birth of the new chemistry. It is a 15 hours course.The corresponding textbook is: Olivier LAFONT, *D'Aristote à Lavoisier les étapes de la naissance d'une science*, Paris, Ellipses, 1994. Each chapter corresponds to one of the items of the course Some lessons are also delivered, from time to time, to sciences teachers and especially to chemistry teachers in secondary cursus. Various subjects were treated such as alchemy or Greek philosophers and chemistry or the idea of acidity according to Nicolas Lemery and its evolution from the first edition of his book to the last edition published during his life, or How to use ancient chemical documents, etc.
[50] Société d'Histoire de la Pharmacie http://www.shp-asso.org/
[51] - http://www.sfc.fr/GrHist/Grhist.htm
[52]. Club Histoire de la chimie, Société Française de Chimie, 250, rue Saint-Jacques, 75005 Paris
[53] The information was compiled by Carsten Reinhardt during. September 2006. Additional information was kindly provided by Ursula Klein, Hans-Guenther Schmalz and Ingo Eilks.
[54] V Geschichte der Chemie (Spezialkurs für Lehramtskandidaten) Textbooks are H. Remane; H. Schmidkunz, "Geschichte der Chemie und Chemieunterricht", in: Naturwissenschaften im Unterricht/Chemie 57 (2000), S. 104–108.; W. H. Brock, Viewegs Geschichte der Chemie, Braunschweig 1977.; W. R. Pötsch et al., *Lexikon bedeutender Chemiker*, Leipzig und Frankfurt am Main 1988/89.
[55] V Nobelpreisträger der Chemie (IX). Textbook : James, L. K., Nobel Laureates in Chemistry 1901-1992, Philadelphia 1993. The course is described as follows: "Nach einem Überblick zum Thema Nobel und seine Preise werden Leben und Werk der Nobelpreisträger der Chemie in den Jahren 1968 bis 1977 vorgestellt. Ihre wissenschaftliche Leistungen werden zur Entwicklung der Chemie und der modernen Naturwissenschaften in Bezug gesetzt. Daneben wird auf die Nobelpreisträger für Physik sowie für Physiologie oder Medizin dieser Jahre eingegangen."
[56] For additional information see http://www.physik.uni-halle.de/Fachgruppen/history/index.html

[57] www.chemiedidaktik.uni-bremen.de. Information provided by I. Eilks.

[58] See http://www.uni-oldenburg.de/histodid/index.html
[59] http://www.uni-bielefeld.de/geschichte/wirtschaftsgeschichte/index.htm. For instance, "Wissenschaft für Krieg und Frieden. Die chemische Industrie als Heilsbringer und Rüstungsmacht"
[60] http://www.pharmtech.tu-bs.de/pharmgesch/indexc3c9.html?id=8; http://www.pharmtech.tu-bs.de/pharmgesch/index7429-2.html?id=15
[61] Instituts für Wissenschafts- und Technikgeschichte (IWTG) und des Lehrstuhls für Technikgeschichte und Industriearchäologie. See http://www.wiwi.tu-freiberg.de/iwtg/index.htm
[62] Studiengang Geschichte der Naturwissenschaften Diplom. See http://www.math.uni-hamburg.de/teaching/curricula/genamath.html
[63] See www-wissenschaftsgeschichte.uni-regensburg.de
[64] Title: "Fleischextrakt, Indigo und Vanillin: Epochemachende chemische Entdeckungen des 19. Jahrhunderts" . Studiengang Magister, B. A. The course is described as follows: "Im 19. Jahrhundert bildete sich nicht nur ein tragfähiges theoretisches Konzept der Chemie heraus, sondern sie trat erstmals auch mit wichtigen praktischen Erfindungen in Erscheinung, die den Alltag der Menschen entscheidend veränderten: Dynamit, synthetische Farbstoffe, die ersten Kunststoffe (Celluloid), Beton, synthetische Arzneimittel (Aspirin), Rübenzucker, das Galvanisieren von Metallobjekten, Insektenvertilgungsmittel und viele andere im 19. Jahrhundert erfundene chemische Produkte mehr werden in ihrem sozial-wirtschafts- und umwelthistorischen Kontext vorgestellt.."

[65] Hochkonjunkturen, Depressionen und Weltkriege - Geschichte der Technischen Chemie im 20. Jh. Studiengang Magister, B. A. The course is described as follows "Die Chemie erlebte in allen ihren Bereichen im 20. Jahrhundert einen einzigartigen, unvergleichlichen und vorher nicht erahnten Aufschwung. Kannte man zu Beginn dieser Zeitspanne lediglich ein paar Zehntausend chemische Verbindungen, so schätzte man deren Zahl zu Beginn des 21. Jahrhunderts auf runde 2 mal 107! In der organischen Chemie lassen sich deutlich drei Hauptepochen

unterscheiden. Zu Beginn die Basis Steinkohlenteer. Dann die Basis Azetylen (Reppe-Chemie) und schließlich Erdöl. Jede dieser Epochen bedingte - vom Versailler Vertrag bis hin zur Gegenwart - sowohl seitens der Rohstoffe, aber auch bei speziellen Produkten (z. B. Sprengstoffe) politische, aber insbesondere geopolitische Konsequenzen".
[66]For additional information, see http://www.uni-stuttgart.de/hi/lehre/KVV06.pdf
[67] Information provided by Hans-Guenther Schmalz.
[68] http://www.mpiwg-berlin.mpg.de/en/index.html
[69] http://www.deutsches-museum.de/
[70] http://www.gdch.de/strukturen/fg/geschichte.htm

[71] Part of this information was kindly provided by E. Varella and Dimitra Kovala – Dermetzi.

[72] . See the digital library project at

[73] Information provided by Dimitra Kovala – Dermetzi.

[74] Information kindly provided by Gabor Pallo. Special thanks also to Eva Vamos. A history of science committee of the Hungarian Academy of Sciences is preparing a survey on teaching history of science in Hungary. For a previous report, see F. Szabadváry, Problems in the Instruction of History of Science and the Teaching of History of Chemistry in Hungary. In: G. Kauffman, *Teaching the History of Chemistry*, Budapest, 1971, pp.211-216.
[75] The Academy of Sciences is one of the organisers of the XXIII International Congress of History of Science. Budapest, 26 - 31 July 2009.

[76] Most of the information was kindly provided by Marco Beretta.

[77]
http://www.unito.it/portale/common.jsp?_pageid=96%2C54819&_dad=portal&_schema=PORTAL&p_action=search&p_rubrica=CERRUTI . Chimica, Corso di laurea in Fisica Storia delle scienze sperimentali, Corso di laurea in Scienza dei Matetriali Fondamenti di Chimica, Corso di Laurea in Comunicazione Scientifica Storia ed epistemologia della scienza, SIS Laboratorio ipertestuale di storia ed epistemologia della scienza, SIS.
[78] http://www.sis-piemonte.it/aree_dsp/04_scien/04_scien.htm. L. Cerruti is editor of a site for students (but not only students) which you will find at the page http://www.minerva.unito.it/
[79] http://www.chem.uniroma1.it/

[80] http://www.spevetro.it/indexENG.htm

[81] The journal is available on-line at the site http://www.didichim.org/

[82] The transactions of the meeting are published. See http://www.accademiaxl.it/GNFSC/ and you may consult an old version of it at the page http://www.filosofia.unibo.it/gnfsc/Gnfsc.htm with a directory (old however) of its members

[83] See the site http://www.accademiaxl.it/Archivi/Cannizzaro/default.php

[84] http://www.imss.fi.it

[85] See http://ppp.unipv.it/Volta/Pages/ePage0.html

[86] Information sent by Mudis Salkauskas.

[87] Order of the Education and Science Minister of 2004 01 22 No. ISAK-87.
[88] Historical narrations could be found in the *Readings on the Organic Chemistry* (Organinės chemijos skaitiniai / sudarė Pranas Buckus. - Kaunas: Šviesa,1994). Or in the biographical book about the first professor of chemistry in Lithuania *Andrius Sniadeckis:* Railiene, Birute. Andrius Sniadeckis. – Vilnius: Vilniaus universiteto leidykla, 2005. – 269 p. One of the most outstanding investigators of history of chemistry in Lithuania was Dr. Zenonas Mačionis. He has published several books on this subject.
[89] Report Ernst Homburg, with the help of Jan van Maanen, Günther Nieuwdorp, Albert Philipse, Lodewijk Palm, Frans van Lunteren, Chunglin Kwa, Harry Lintsen, Jetse Reijenga, Herman van Bekkum, Frida de Jong.

[90] As course book the Dutch translation of Marco Beretta's *Lavoisier: la rivoluzione chimica* is used.
[91] For more information, see: www.phys.uu.nl/onderwijs/opleidingsinformatie/minors/gesfilnat/
[92] (*De ontdekking van het weten: een andere geschiedenis van de wetenschap* (The discovery of knowing: another history of science) (Amsterdam: Boom, 2005))

[93] Information kindly provided by Annette.Lykknes.

[94] Textbook: Trevor Levere, *Transforming Matter* (John Hopkins, 2001) + copies of articles from books and journals
[95] The main textbook is Peter J. Bowler, Iwan Rhys Morus: *Making Modern Science: A Historical Survey* (University of Chicago Press, 2005).
[96] John Hudson's "The history of chemistry" is employed as the main textbook and some texts written by the professor about Norwegian chemical and metallurgical industry.
[97] Information kindly provided by Iwona Maciejowska, Jan Milecki and Janusz Ryczkowski.
[98] Course code: Cf02W. The origins of chemistry. Development and technological achievements in chemistry domain during copper, bronze, and iron eras. Evolution of practical chemistry in ancient countries of Mediterranean Basin, India, and China. Greek philosophers' concepts on structure of matter. The beginning of an alchemy. Arabian (VIII – XIII centuries) and European (X – XVII centuries) alchemy. Speculative and practical alchemy. Discovery of new elements, chemical associations, development of equipment. Avicenna – philosopher, alchemist, father of medicine and pharmacy. Volumes in Arabian libraries, discoveries of European alchemists (Albert The Great, R. Bacon). Pseudo-Geber – the alchemy language. Works of Agricola. Yatrochemistry. Phlogiston theory. The beginning of scientific chemistry. Chemistry development in XVIII-XX centuries: basic chemical laws, chemical symbols – the Periodic Table. Development of organic chemistry. Radiation. Isotopes. The history of atom structure theory. Development of chemistry in Poland. Polish alchemists – Michał Sędziwój. Chemistry in Szkoła Główna Koronna – history of chemistry at Jagiellonian University. Development of chemistry at Universities of Vilnius, Lvov, Warsaw and Poznan. International and Polish scientific societies and organizations. Textbooks: Partington J.R., *A History of Chemistry,* MACMILLAN & COLTD, London, vol.1, 1960, vol.2, 1962, vol.3, 1964, vol.4, 1966; Wojtaszek Z., Kuzyk H., Morzyniec A., Dubowy J., Łopata K., *Karol Olszewski*, Universitatis Iagellonicae Acta Chimica, Kraków, 1990; Bugaj R. *Hermetyzm*, Zakład Narodowy im. Ossolińskich, Wrocław, Warszawa, Kraków,1991; Wojtaszek Z., Studia z dziejów Katedr Wydziału Matematyki, Fizyki i Chemii Uniwersytetu Jagiellońskiego, Kraków 1964; Hubicki W., Z dziejów chemii i alchemii, Wydawnictwo Naukowo-Techniczne, Warszawa, 1991.
[99] http://chemia.umcs.lublin.pl/index-e.htm

[100] http://www.guide.amu.edu.pl/amu/index-xmas.htm

[101] Information kindly provided by Ana Carneiro, António Amorim da Costa, Bernardo Herold. and Ana Barros.
[102] The lectures included a first part on methodological issues and a second part on "fundamental topics on the history of chemical ideas" covering topics such as alchemy, early modern chemistry, chemical revolution, atoms and elements, the birth of organic chemistry, the idea of valency and structural chemistry, periodic table, the profession of chemists, chemistry in Portugal, the assymetrical carbon and the development of physical chemistry, quantum chemistry, biochemistry and biotechnology. The bibliography included a large list of books and papers, for instance, T. Levere, *Transforming Matter. A History of Chemistry from Alchemy to the Buckyball*, (Baltimore/London: The Johns Hopkins University Press, 2001); B. Bensaude-Vincent; I. Stengers, *História da Química*, (trad.) (Lisboa: Instituto Piaget, 1996). A. M. Nunes dos Santos, "Prefácio", in Guyton de Morveau ; A. L. Lavoisier; C. L. Bethollet ; A. F. Fourcroy, *Méthode de Nomenclature* (fac-simile), A. M. Nunes dos Santos, ed., (Lisboa: Petrogal S.A., 1991); W. H. Brock, *The Fontana History of Chemistry* (London: Fontana Press, 1992), A. M. Amorim da Costa, *Primórdios da Ciência Química em Portugal*, (Lisboa: Instituto de Cultura e Língua Portuguesa, 1984), etc. An additional list of reference books and bibliography was provided for graduate students.
[103] Information provided by professor Bernardo Herold.
[104] Most of the information has been kindly provided by Elena Zaitseva.
[105] According to Y. I.Solovyev, the first courses on history of chemistry in the USSR were taught in 1946 at the Moscow University. The chair was occupied by professor N.A. Figurovskii. See Y. I. Solovyev, Teaching the History of Chemistry in Russia. In: G. Kauffman, *Teaching the History of Chemistry*, Budapest, 1971, pp. 217-222. At chemical faculty of Moscow university there is no division into bachelor and master courses of study. All student pass through compulsory 5-year course of study. See http://www.chem.msu.su/eng/courses-and-degrees.html
[106] 32 hours, for students of second year of study (IV semester), read by Ass.Prof. O.N.Zefirova, teacher T.V.Bogatova, V.V.Lunin (Dean of faculty) and heads of chemical faculty chairs and also representatives of university branch in Chernogolovka, Moscow region). The course includes lectures on the history of development of chemistry in Russia from ancient times to the beginning of XXth century and also covers issues of formation of major Russian chemical schools, participation of chemists in activity of scientific communities. For this theme 15 hours are assigned.

Next part (17 hours) is dedicated to development of chemical research at chemical faculty from its beginning, within separate chairs. The course is compulsory, attestation in form of a pass.

[107] 24 hours, for graduate students (IX semester), read by O.N.Zefirova, several lectures are given by professors B.V.Romanovskii and E.P.Ageev). The course of lectures (intended for students of fifth year of study) covers material from natural philosophy studies of ancient Greece and alchemy to chemistry of XXth century and 50% of lecture time is dedicated to history of chemistry of XXth century. The course is also compulsory, attestation in form of a pass. In course of study lecturers organize for students tests in writing that are considered for final passing.

[108] This museum represents a memorial chemical laboratory of XIX century, where chemicals and laboratory equipment of XIX-XX centuries is exhibited.

[109] The information has been kindly provided by Alex Bilibin.

[110] The information has been kindly provided by Marjan Veber.

[111] . http://www.fkkt.uni-lj.si/en/?487

[112] Most of the information has been gathered and kindly provided by Pedro J. Campos who analysed the data in a recent conference. See http://www.ehu.es/proman/jornadas/inicio.htm

[113] Spanish translations: B. Bensande-Vicent, Y. Stengers, “Historia de la Química”, Addison-Wesley/ Univ. Autónoma de Madrid, Madrid, 1997; W. H. Brock, "Historia de la Química", Alianza Editorial, Madrid, 1998.; B. Wojtkowiak, "Historia de la Química", Editorial Acribia, Zaragoza, 1987; I. Asimov, "Breve historia de la Química", Alianza Editorial, Madrid, 1984; H.M. Leicester, “Panorama histórico de la química”, Alhambra, Madrid, 1967; J.R. Partington, “Historia de la Química” Espasa Calpe, Madrid, 1945.
Textbooks written by Spanish authors: F. Aragón de la Cruz, “Historia de la Química”, Editorial Síntesis, Madrid, 2004; M.C. Izquierdo, et. al., “Evolución histórica de los principios de la Química”, UNED Edic., Madrid, 2003; S. Esteban Santos, “Introducción a la Historia de la Química”, UNED Edic., Madrid, 2001; Many other books (biographies, studies on particular topics) are available in Spanish and other Peninsular languages.

[114] http://www.udc.es/estudos/ga/planes/610311.asp

[115] Professor : Agustí Nieto Galán.

[116] Professor: Argelio Manuel Rancel. The title is “Evolution of theories and methods of chemistry” :

[117]Professor: L. Vicente Pérez Arribas. Additional information: http://www.ucm.es/info/ccquim/content.htm?nivel1/Titulaciones.htm

Topics: Early Chemistry. Chemistry And Physics In The XVII And XVIII Centuries. The Origins Of Organic Chemistry. Electrolysis. The Periodical System Of Elements. The Atomic Structure. From Chemistry To Industry. Progress In The XX Century. Textbooks: W.H. Brock. “Historia de la Química”. Alianza. 1998; Henry M Leicester. “Panorama histórico de la Química”. Alhambra. 1967; S. Esteban Santos “Introducción a la Historia de la Química” UNED Ediciones Madrid-2001; J. Hudson “The History of Chemistry” Chapman & Hall New York-1994; F. Aragón de la Cruz “Historia de la Química” Ed. Síntesis Madrid 2004

[118] Professor: José Cano Pavón. The title is “Evolution of the chemical knowledge and bibliography”.

[119] Professor: Pedro J. Campos

[120] Professor : José Ramón Bertomeu Sánchez. See http://www.uv.es/bertomeu

[121] Prof: Juan Antonio Pérez-Bustamante de Monasterio. See http://www2.uca.es/basesdatos/fichasig/ver.php?asignatura=206040&titulacion=0206&departamento=C126

[122] Professors: Alberto Gomis Blanco and Raúl Rodríguez Nozal:

[123] http://einstein.uab.es/suab237w/eng/default.htm

[124] Information kindly provided by Anders Lundgren and Carlaxel Andersson.

[125] Some examples of textbooks on history of science and ideas: Gunnar Eriksson, *Västerlandet idéhistoria 1800-1950* (1983) [History of ideas in the West]
Tore Frängsmyr, *Svensk idehistoria* (2000), [Swedish history of ideas]. There is not much chemistry in these books.

[126] Information by Anders Lundgren.
[127] http://www.vethist.idehist.uu.se/English/index_eng.html. See information about the last summer school.
[128] http://www.lu.se/. Information by Carlaxel Andersson.

[129] Information kindly provided by Peter Morris. Special thanks also to Matthew Eddy and Andrew Hughes. For a former report see M.P. Crosland, A View of the Teaching of the History of Chemistry from the University of Leeds, England. In: G. Kauffman, *Teaching the History of Chemistry*, Budapest, 1971, pp.197-205.
[130] http://www.dur.ac.uk/faculty.handbook/module_description/?year=2006&module_code=PHIL1061

[131] http://www.dur.ac.uk/faculty.handbook/module_description/?year=2006&module_code=PHIL1071

[132] Information provided by Eddy and Andrew Hughes. Up to perhaps 5 students per year (out of 100) students select these two mentioned courses.
[133] http://www.chem.ox.ac.uk/teaching/partIIInstrtoCand.html; http://www.chem.ox.ac.uk/teaching/partIIhistory.html
[134] http://www.chem.qmul.ac.uk/rschg/
[135] http://www.ambix.org/

[136] A similar situation was reported in USA. See HEILBRON, J.L.; KEVLES, D.J. (1988), Science and Technology in U.S. History Textbooks: What's There--and What Ought bo Be There, *Reviews in American History*, *16*, 173-85.

[137] *Histoire de la chimie*, Paris, La découverte, 1993. (2nd edition, 2001). The book has been translated into English, Spanish, Portuguese and many other languages.

[138] BROCK, W.H. (1992), *History of Chemistry*, London, Fontana Press, 477 p. There are other most recent English editions and many translations into Spanish, German, etc.

[139] Trevor H. Levere, *Transforming Matter: A History of Chemistry from Alchemy to the Buckyball*, Johns Hopkins Introductory Studies in the History of Science, 2001.
[140] J. Hudson, *History of Chemistry,* Chapman & Hall (December 1992)
[141] See report for details.
[142] http://www.cpe.fr/ectn-assoc/eurobachelor/