**Muriel Guedj *, Sylvain Laubé ****

# History of sciences in the French teachers training

## (1) Introduction

After having pointed out the broad outline of the French institutional request, we will show the specificities and the questions raised by teachers training. Lastly, we will present the objectives of the ReForEHST group by specifying his actions and those to come at European level.

## (2) The French institutional request

The history of sciences and technology occupies today a significant place in the school curricula, particularly those of the grammar and high school. This interest for the history of sciences and technology takes part in a more general intention which aims to support acquisition by the pupils of a "scientific culture" as well as the literary culture or the artistic culture. Thus, the "*article 9 de la loi d'orientation et de programme pour l'avenir de l'école du 23 avril 2005*", known as law Fillon, registers "a humanistic and scientific culture allowing the free practise of the citizenship" in the "common base of knowledge" that any pupil will have to posses at the end of the compulsory schooling. The project of decree relating to this "common base" specifies the contribution of historical dimension in the acquisition of a scientific and technological culture: "The presentation of the history of discovered laws and the development steps of the concepts, by mobilizing the resources of all the concerned disciplines, constitute in particular an effective way to approach complexity: the historical prospect contributes to give a coherent vision of sciences and technology and their joint development".[1]

The promotion of the scientific culture — and consequently of the history of sciences — at school is linked to the report, for a few years, of a disaffection in the scientific studies and the objective to increase significantly the proportion of graduates (and among the latter, the proportion of girls) in the scientific high education. From this point of view, insistence on the "cultural" aspect of sciences, and in particular on their historical dimension, mainly aims that "pupils appreciate sciences".[2] In addition, according to the Lecourt Report[3] in 1999, a historical approach can contribute to a better knowledge of science and scientific research as well as the values which they convey. If the major reasons of this promotion of the scientific culture within the school institution can be discussed, it is necessary, on the other hand, to take note of the effective introduction, since the beginning of the years 2000, of elements of history of sciences and technology in the curricula of mathematics, sciences and technology, in grammar, high and even primary school. Thus, the application document of 2002[4] concerning the 8–10 years pupils (Cycle 3) underlines the need for giving a historical dimension to the concept of evolution of the alive beings: to locate the great stages of the history of the life on Earth, to discover that the mankind evolved/moved in the course of time, etc. In the same way, in grammar school, the new curricula 2005[5] for of physic sciences propose a lot of openings in direction of the history of sciences, while those of technology pointed out , inter alia, that pupils have to be aware "that science and technology have a common history marked out of discoverings and innovations […] and that this

* IUFM de Montpellier, Montpellier, France; email: muriel.guedj@montpellier.iufm.fr.

** IUFM de Bretagne, Brest, France; email: sylvain.laube@bretagne.iufm.fr.

[1] http://trf.education.gouv.fr/pub/edutel/actu/2006/projet_decret_annexe.pdf.

[2] *BOEN* Hors série n° 2 du 30 août 2001, pp. 8–9.

[3] D. Lecourt, *L'enseignement de la philosophie des sciences*, septembre 1999. To read at: http://www.education.gouv.fr/rapport/lecourt/default.htm.

[4] http://www.cndp.fr/doc_administrative/.

[5] *BOEN* Hors série n°5 du 25 août 2005 to read at http://www.education.gouv.fr/bo/2005/hs5/default.htm.

history is registered in that of the society".[6] Lastly, in high school, a particular importance is given to the "historical presentation": the curriculla concerning the last year (17 year-old pupils) in mathematics recommend for example to introduce "some elements […] giving a historical dimension" to the study of the complex numbers.

Not only the scientific disciplines are concerned with the history of sciences and technology, the historical discipline itself is also mobilized. At primary school, for example, the curriculum in history evokes "scientific and technical progress" as being a essential vector of the evolution of the French (and occidental ) society in the 20th century. More generally, a collaboration between the various disciplinary fields is recommended. The appendix in the scientific curricula of the grammar school (2001) indicates, thus, that "a certain number of scientific and emblematic developments will be examined, at the same time, in the sciences and history classes whose renovated curricula will include this dimension".[7] Moreover, it is advisable to note that the teaching of philosophy (17 year-old pupils) in 2003 curricula is based on "the literary and artistic culture, the knowledge scientific and the knowledge of the history".[8]

## (3) Teachers training

The contribution of the history of sciences and technology to the teachers training can be described according to two (and complementary) directions. On one hand, because it is registered in the school curricula, the history of sciences and technology constitutes in fact one of the facets of a training aiming at the taught contents. In addition, one of the missions of the teachers training is to bring lightings of epistemological and historical nature on the taught disciplines. In this respect, the official texts have a general range, insofar as they are addressed to all teachers/trainers, for all disciplines. The instruction of May 23, 1997 indicates that the teacher (in the secondary school) must know how "to locate the current state of his discipline, through his history, his epistemological stakes, his didactic problems and the debates which cross it". More recently, the instruction (April 4, 2002) relating to the organization of the second year of teachers training asks to the IUFM[9] trainers to show, for a discipline or a given disciplinary field, the principal contributions of epistemology and history.[10] This historical and epistemological dimension is also in the conditions of a contract for teachers training worked out in 2005 by the Conference of the IUFM directors, which stresses the "school disciplines": the epistemology and the history of the disciplines — and in particular the epistemology and history of sciences and technology — mobilized within the framework of the teachers training relate to the "knowledge to be taught" as well as the "erudite knowledge".

If the institutional request registers the EHST like a component of the teachers training, this request remains however too vague and makes difficult the integration of the EHST. Moreover, it is essential to specify in what the EHST (apart from the arguments related to the scientific and technical culture), is justified within the professional training. In addition, it is advisable to note different approaches in the school programs.

Thus, in the physics-chemistry program of the grammar school, the introduction of a historical prospect relies on the idea to give a coherent vision of sciences. The world is understandable and was the subject of a progressive human construction, the two ideas are supplemented without no contradiction being perceived. On an other hand, the programs of mathematics and life sciences, it is the method of investigation and resolutions of problems which is put in connection with the history of sciences, in particular by the choice of learning problems drawn from a historical bottom. This hiatus between a history of sciences giving a 'global vision' of sciences (or world) and examples to found a step of investigation, is obviously important because that results in extremely differences in practices and

[6] *BOEN* n° 3 du 20 janvier 2005, p. 110. See also the document: *La rénovation des programmes du collège. Consultation sur les projets proposés par le groupe d'experts. Technologie au cycle central*, to read at http://eduscol.education.fr/D0082/accueil.htm.

[7] *BOEN* Hors série n°2 du 30 août 2001, volume 7, p. 8.

[8] *BOEN* n° 25 du 19 juin 2003, p. 1301.

[9] *Institut Universitaire de Formation des Maîtres*.

[10] *BOEN* n° 15 du 11 avril 2002.

reference documentation. All in all, it is clear that the new programs tend to rather privilege the first aspect on the second, especially on the level of the grammar school.

Now, in teachers training, this hiatus is inevitably found: in one hand, it is necessary to give to the teachers, through the epistemology and the history of sciences, a global vision (a "macro-history"), on the other hand it acts to provide them historical examples (of scientific steps, problems or experiments,…: a "micro-history"), but also tools for analysis of real scientific situations allowing to feed the reflexions on the steps of the pupils. Perhaps, it is not possible (nor even) desirable to slice between these two points of view which one can perceive either like reconcilable between them, or like contradictory.

A "macro-history" engages a type of history of sciences related to an progressist, hagiographic and coherent narration. This approach is often centered on a specific disciplinary field and relies mainly on the secondary literature of which it constitutes a synthesis. This model of teaching, which generally imposes a teaching as "lecture" type, asks essential questions:

- What learning contents to build what wished coherence?
- How to justify such ambitions taking into account the very weak schedules generally granted to this type of teaching?
- What methodological contributions does this approach develop related to the teachers professionnality?
- Shouldn't this type of teaching be proposed first at the university?

Another approach relies on a teaching focused on case studies. This approach (which one could describe as "micro-history") allows to consider a certain complexity of the scientific steps. In particular, it underlines the fact that the latter are not necessarily finalized on a progress or the discovery of a coherent vision of the world. It shows the diversity to be taken into account: temporal, political, cultural, social, etc. Dimensions, and invites to become aware of the tension between the "micro" and "macro" approaches. In addition, mainly centered on study of primary texts, it authorizes a diversification of way to teach and objectives. The diversity of objectives which it is possible to aim with this type of approach can be partially illustrated thanks to the following examples:

- "The Coulomb's balance"[11] constitutes a case study making it possible to work in another way the university knowledge and the knowledge to be taught. Because these historic experiment has been replicated by P. Heering[12] and is very well documented, the work with the neo-teachers consists in several stages :

    1) to understand the principle of the balance as scientific instrument and the procedure to measure the angle at equilibrium in order to show that the repulsive force follows a Newtonian-like inverse square Law.

    2) to analyse sources of errors like: non-linearity of the torsion wire when is twisted, charge repartition in conductors and the question of the diameter of the balls, electrostatic influence of the environment from the results of P. Heering works.

    3) to discuss the role of the experiment versus theory in this case study with a historical point of a view.

    4) to prepare a course on the Coulomb's law to be tested in class.

We want to show with this example that to understand such historical and fundamental experiments is a way to work several point of the teacher professionality: the learned knowledge in university, skills to analyse scientific and epistemological problems and scientific culture.

[11] Coulomb C.A.," Premier Mémoire sur l'Électricité & le Magnétisme", *Histoire de l'Académie royale des sciences* (1788 pour l'année 1785), p. 569–578; http://gallica.bnf.fr/ark:/12148/bpt6k35847/f769.table .

[12] "The replication of the torsion balance experiment: The inverse square Law and its refutation by early 19th-century German physicists", in: Ch. Blondel & M. Dörries (eds.): *Restaging Coulomb: Usages, Controverses et réplications autour de la balance de torsion* (Firenze: Leo S. Olschki, 1994), p. 47–66.

- Historical knowledge allows to help the didactic analysis (in certain case) by highlighting of epistemological obstacles. First example, the intuitive representations of child in mechanics about motion and weights can be close of an aristotelician point of view [13] and the reading of the Galilean works is a very good way to understand this intuitive physics and to imaginate some didactic solutions, especially concerning vertical and horizontal motion. A second example is illustrated in recent didactic works[14] where it is shown that young pupils explain vision either in a direction eye-object or in a direction object-eye and the ancient and medieval history is pilot similar ideas: like the pupils, the scientists are opposed on the direction of the sight.
- The article *"To use historical texts in the teaching of the physical sciences in class of second of the French high school"*[15] shows that it is possible to work starting from concrete examples to explore in class. This article [16] presents a proposal for an introduction of elements of history of sciences in class of 15 year-old pupil inhigh school in order to improve the training of mechanics. Centered on the exploitation in class of primary sources, this work aims at developing capacities of questioning at the pupils.
- To analyze scientific and technical problems which were real problems and not factitious situations manufactured for teaching and to work on methods and forms of argumentation which are associated to them. This aspect is essential and it lies within the scope of the new directives which engage to develop bye the pupils the capacity to achieve a step of investigation. The communication *Constructing the Steps of the Scientific Method Using Historical Texts: The Case of French Students Majoring in Physics* [17] explains for the work undertaken with a group of students in physics Licence at University. Different experimental approaches were compared and the stakes related to these differences were analyzed. Two famous texts were proposed to the students. The first by Hempel [18] is the description of the attempts implemented by I. Sommelweis to save women from the puerperal fever. The described experimental step appears caricatural and seems to proceed by gropings, tests and errors. In opposite, the second text (a letter by Perier to Pascal in 1648[19]) presents the experiment as resulting from a rational assumption built within a precise theoretical framework. Consequently, the role of experiment is to check assumptions. The students had to locate in each text the various stages of the step (problem, assumption, experiment, result, interpretation, conclusion), and to assign to each one of these parts a label allowing a precise location. The following stage consisted in comparing the fitting of the labels and analyzing the divergences in term of choice of step.

In addition, this "micro-history" makes it possible to work on the historical and didactic nature of the bond between the "erudite knowledge" and the "knowledge to be taught". Indeed, the study and the analysis of the knowledge genesis in sciences, the curricula texts and the principal orientations of the great reforms of teaching, while constituting an element of professionnality registered in the teachers training, allow a better comprehension of the current knowledge to teach and methods. The example of the exposition "Science à l'école: quelle histoire !" is significant of the interest of such a teaching step. The work, starting from this exposition concerning sciences teaching in the primary school during the period 19th–20th centuries, was held in several stages. Thus, from an initial questionnaire, the future teachers were sensitized with the questions related to the different choices operated (science in urban environment or rural, science for the girls, sciences for the boys…). All these questions aimed at

[13] See: *A Cross-Cultural Study on Intuitive Physics*, http://echo.mpiwg-berlin.mpg.de/content/intuitivephysics.

[14] C. De Hosson (2004): *Contribution à l'analyse des interactions entre histoire et didactique des sciences. Elaboration d'un support d'enseignement du mécanisme optique de la vision pour l'école primaire et le collège et premiers éléments d'évaluation*; http://tel.archives-ouvertes.fr/tel-00083593/en/.

[15] M. Guedj (2005a): "Utiliser des textes historiques dans l'enseignement des sciences physiques en classe de seconde des lycées français: compte rendu d'innovation", *Didaskalia* n°26, mai 2005.

[16] M. Guedj (2005b): "Constructing the Steps of the Scientific Method Using Historical Texts: The Case of French Students Majoring in Physics", in: *Teaching and communicating science: what the history, philosophy and sociology of science can contribute* (University of Leeds, July 2005)..

[17] Carl Hempel, *Eléments d'épistémologie*, ed. by Armand Colin (2002).

[18] http://gallica.bnf.fr/ark:/12148/bpt6k105083f.

[19] http://www.iufm.education.fr/connaitre-iufm/partenariats/sciencesalecole/index.html.

giving a temporal dimension to the teaching of sciences which is not "fixed in its form" but which results constantly from significant and social choices of science that the education institution wishes to see taught. Extracts of handbooks (covers, synopsis, foreword and some lessons) of the various periods made it possible to compare the contents as well as the methods to examine, over the period concerned, the conveyed values and the aims of such a teaching. A post-test following the visit of the exposition made it possible to give a final view on all the studied questions.

We have just underlined certain significant elements from the contribution of the EHST for the teachers training. However, it is imperative, if one wishes to develop truly this type of teaching, to take into account the following questions:

- What primary and reference texts, in bond with the programs (well adapted contents, methods and level of difficulty) can a teacher choose?
- Where can he find this reference texts, how to be certain to work on French translations of quality?
- What teaching methods to use with these texts? What didactic situations?
- How to evaluate the professionnality of the teachers?

Obviously, these questions engage towards researches which constitute one of the orientations taken by the ReForEHST group.

## (4) The ReForEHST group

The group "Recherche et Formation en Epistémologie et Histoire des Sciences et des Techniques"[20] (ReForEHST)" was created in September 2004 after the congress of the French Society of History of Sciences and Technology which was held in Poitiers in May 2004. The session "Teaching and History of sciences and technology" directed by Helene Gispert and Danièle Fauque made it possible to gather historians and epistemologists who were all trainers (in different IUFM: Brest, Caen, Creteil, Montpellier, Poitiers and Versailles) and are the founder members of the group.

Work of the group takes several orientations: to establish an inventory of existing research and teachers training, to support creation of a network for the community of trainers in EHST, to initiate and promote activities of research and production of didactic tools within the IUFM.
Two meetings allowed works and debates about the questions described above (what history of sciences and technology in IUFM? What research? Which bonds between epistemology, history of sciences and technology and didactic? …) and a mutualisation of the teaching practices. Thus, the first colloquium was held in the IUFM of Montpellier in May 2005,[21] the second one in Anthony in January 2006 whereas the next meetings will be in Caen in June 2007 and, at last, an international conference is planed in Paris for 2008.

In addition, a mailing list gathering forty people allows exchanges and a ReForEHST website (http://plates.formes.iufm.fr/ehst/) gathers various work of the group and resources on-line for the teachers. A project of booklets — joining together a collection of primary texts with accompanying notes will regularly come to supplement these resources.

From the constation that the EHST teachers trainings are based on institutional research, it is also essential to note that conversely such trainings can generate questions of research. For exemple, the historical analysis of the primary school textbooks (evoked above) shows that some knowledges are perennial on a large period (19th–20th centuries): it is the case of the materiality of the air, whereas other fields (like electricity) undergo changes whose origin is always interesting to examine.

In 2006, a seminar has thus been created to aim at characterizing the passage of the science which is done in laboratory with the science which is taught: it is necessary to question the conditions of this passage, of this transformation or rebuilding of the knowledge with historical and didactical points of views.[22]

[20] For "Research and Training in Epistemology and History of sciences and Technology".

[21] « Histoire des sciences formations et recherches en IUFM », Tréma, IUFM de Montpellier, n°26, Octobre 2006, email: histoireeducation@montpellier.iufm.fr.

[22] Four laboratories are concerned: Centre F. Viète (Nantes), CREAD (Rennes2), CREN (Nantes) et CERSE (Caen), see: http://dionysos.bretagne.iufm.fr/formation_formateur/documentation/plan_formation.php?code_type=3&site_web=O#79.

If the actions carried out by the ReforEHST group in term of formation and research are at a French level, it is relevant to extend the problems to a European dimension and it is to be wished to create at European level a network of researchers and trainers on this thema. This prospect could lead on the creation of a European website of resources for the teachers gathering translated historical texts and allowing a mutualisation of the practices. In addition, generating co-operative research at the European level would constitute a decisive stage opening prospects in the fields of the history of science education, but also in those of the history of sciences often attached to a framework (geographical, national, institutional…) who restricted and sources and analyses.

## (5) Conclusion

We have tried to show in this paper that "EHST in teacher education" constitutes a thema where questions are connected to several fields: history od sciences and technology, epistemology and didactic. To answer to the questions requires specific research and production of specific tools dedicated to the teachers training. At the present time, there are many possibilities of obtaining on line primary and fundamental history texts, but there are several obstacles: it is necessary to be an expert of the field to find these resources, they are not commented on their historical scientific context and their interest for teacher education and, of course, they are not translated. As example, one will be able to find easily Galileo works in Italian[23] or Boyle works in English[24] but not in French translation. On these two points (research and publication on line in several languages), only a community of European researchers concerned with the teachers training could allow to advance in this direction and to give common and adapted tools at the disposal of European teachers and trainers.

[23] *Le opere di Galileo Galilei*, see: http://gallica.bnf.fr/ark:/12148/bpt6k94893t for Volume I.

[24] Boyle R. (1660): *New experiments physico-mechanicall, touching the spring of the air and its effects*, see: http://archimedes.mpiwg-berlin.mpg.de/cgi-bin/toc/toc.cgi.