

# HISTORY OF SCIENCE AND TECHNOLOGY IN THE FRENCH SYSTEM FOR TEACHER TRAINING

ABOUT A RECENT INITIATIVE

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## Abstract

*This paper is about a recent French undertaking to promote, and reflect on, epistemology and history of sciences and techniques for both teacher training and science teaching, mainly within France but also at the European level. This action was undertaken in 2005 by the 'ReForEHST' group, which now gathers some ten historians of science implied in teacher training. We give a sample of issues and difficulties that were discussed in the framework of the three meetings organized thus far by this group, concerning the introduction of a historical perspective in teaching and teacher training. We finally propose a strategy to confront these difficulties that we illustrate on a few examples.*

## 1 THE REFOREHST GROUP: WHAT IT IS AND WHAT IS ITS PURPOSE

This initiative was prompted in the 2004 meeting of the French society for history of science (SFHST), in which a group of seven persons made the decision to organize a new meeting entirely devoted to this and the related issues. All seven were historians of science at a professional level, working in one of the recognized institutes for history of science in France. At the same time, they were all working in teacher training within the "Instituts Universitaires de Formation des Maîtres" (IUFM)<sup>1</sup>, at the rank of research assistants. Finally, they all felt the urgent need to cooperate and reflect on various issues related to history of sciences within teacher training and science teaching and shared by many other members of the educational community.

The main ambitions of the group were, and still are, the following: first, to create and/or sustain a community of teachers, teacher trainers and professional historians working on, using, or simply interested in, the history and epistemology of sciences and techniques; second, to promote research and training activities within this community; third, to produce historical resources that may be useful and accessible to teachers as well as to teacher trainers; finally, to obtain some official recognition for these activities.

These goals are obviously very similar to those of the French IREM<sup>2</sup>, which were created in the seventies to accompany the modern mathematics reform and have since then, as far as the history and epistemology of mathematics is concerned, created a considerable amount of

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<sup>1</sup>Literaly 'Academic Institutes for Teacher Training'

<sup>2</sup>Instituts de Recherche sur l'Enseignement des Mathématiques, Insitute for Research on Mathematics Teaching. See their website <http://www.univ-irem.fr>

resources<sup>3</sup>. The two main difference are that the ReForEHST initiative concerns specifically history and epistemology of science within science teaching (and not science teaching in general), and that it concerns the history of sciences (including experimental sciences) and technology in general and not only of mathematics. This difference is well reflected by the domains of interest of the members of the group, namely history and philosophy of mathematics<sup>4</sup> history, epistemology and didactics of physics,<sup>5</sup> history and epistemology of biology and geology<sup>6</sup> and didactics of the EHST<sup>7</sup>. Unfortunately, the group still has no representative of the history of technology.

Since its establishment, the group, which has now taken the name ReForEHST for ‘Recherche et Formation en Epistémologie et en Histoire des Sciences et des Techniques’<sup>8</sup> has taken several concrete steps to promote its aims. A first meeting; consisting of lectures and working groups, was organized in Montpellier in May 2005<sup>9</sup>. The same year, the group planned a website<sup>10</sup>, a mailing list and a new meeting. The latter was organized in Jan 2006 in Antony (near Paris), and included the possibility to present in thematic workshops teacher training activities<sup>11</sup>. Finally, the last ReForEHST meeting was recently organized in Caen on a more particular theme (history of science and active pedagogy) and offered the possibility to present either research papers or teacher training activities<sup>12</sup>.

## 2 SOME THORNY ISSUES LYING BEHIND THIS INITIATIVE

The first ReForEHST discussions and efforts have help us to bring out a series of deep issues, some of them quite difficult, touching either on the motivations of our action or more generally on the legitimacy of history of science in teacher training. We present here a sample of such issues in the form of provocative questions, before we explain our strategy to address them.<sup>13</sup>

*Concerning the idea of creating a community around history of science in teacher training.* The idea seems fine and has been realized, to some extent, by the meetings we organized. But this is obviously not enough: the main, deep issue hidden behind this modest attempt is to give the people concerned the means and places to work<sup>14</sup>. We believe that many teachers

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<sup>3</sup>See Evelyne Barbin’s general introduction to this summer university as well as her paper “Apport de l’histoire des mathématiques et de l’histoire des sciences dans l’enseignement” in (ReForEHST 2006).

<sup>4</sup>Alain Bernard, IUFM of Créteil, Renaud d’Enfert, IUFM of Versailles, Yannis Delmas, IUFM of Poitou-Charentes, Dominique Tournès, IUFM of Réunion, Thomas de Vittori, IUFM of Bretagne. For Alain Bernard, Renaud D’Enfert and Dominique Tournès, the reader may look into their respective contributions for the Prague ESU-5 to have a more precise idea of their key interests.

<sup>5</sup>Muriel Guedj, IUFM of Montpellier Sylvain Laubé, IUFM of Bretagne Arnaud Mayrargue, IUFM Créteil.

<sup>6</sup>Pierre Savaton, IUFM de Caen, Johann-Günther Egginger, IUFM of Lille, Hervé Fériere, IUFM de Bretagne.

<sup>7</sup>See Guedj, Laubé & Savaton (2007)

<sup>8</sup>Research and Training in Epistemology and History of the Sciences and Technology

<sup>9</sup>The detailed conclusions are available in French in (ReForEHST 2006); see <http://www.montpellier.iufm.fr/internet/site/recherche/revuetrema/modele/index.php?f=parutions>.

<sup>10</sup>See <http://plates-formes.iufm.fr/ehst>

<sup>11</sup>See the program on [http://plates-formes.iufm.fr/ehst/article.php3?id\\_article=9](http://plates-formes.iufm.fr/ehst/article.php3?id_article=9)

<sup>12</sup>A summary of the interventions is available (in French) on [http://plates-formes.iufm.fr/ehst/article.php3?id\\_article=37](http://plates-formes.iufm.fr/ehst/article.php3?id_article=37) and the proceedings should be published soon in a special issue of the *Cahiers du Centre François Viète*.

<sup>13</sup>The present paper is based mainly on two papers describing in some detail our action, the first one to be published (in French) in a special issue devoted to the life and work of René Taton (Bernard, forthcoming); the second one to be published in the proceedings of the Cracow meeting of the ESHS (<http://www.eshs.org/index.html>) (Guedj & Laubé, 2006).

<sup>14</sup>For comparison, the IREM experience was successful because it gave many teachers the concrete means to work together, whatever their position within the institutions, and produce useful resources for the *milieu* of mathematics teachers in France. Beyond the pure material question (the financial means awarded for such activities) there was the fundamental idea that the math modern reform should be accompanied by a significant and permanent effort toward teacher training.

or teacher trainers from various scientific disciplines (other than mathematics) are now eager to find such working conditions to develop their potentialities and reflections, as is proven by local experiences. But it remains to define on a large scale what should be the guiding principles and *raison d'être* of such working groups.

*Concerning the idea that history and epistemology of science should be studied.* The idea in principle is widely accepted in the profession and is stated as a general goal in many official recommendations concerning science teaching or teacher training. But this general idea hides difficulties as to *whom* such teaching should concern and *the ways* in which it should be taught. Concerning the *whom*, the particular question arises, whether teachers *and* students should be taught history of science and if so, whether this should be done in the same way or for the same purposes. This question necessarily arises when one considers that the official recommendations, depending on the discipline, do not encourage history of science for the same purposes; in certain cases, for example, they often imply that teachers should know history of science exclusively for the sake of teaching it to their students. Experience shows, by contrast, that many teacher gain much from such studies even when it is not aimed directly at teaching history of science in the classroom.

*Concerning again the idea that history of science be taught to students:* even when this idea is accepted, let alone because official recommendations encourage it one way or another, difficult issues remain regarding the *kind* of history of science to be taught and for what purpose. It is obviously not the same to promote the history of science as an essentially cultural subject; or as a way of encouraging students to embrace scientific or technical careers; or as an aid for science teaching. It is, of course, always possible to argue that all these purposes are attained at the same time; but this begs the difficult question as to whether these purposes (all met in various official policy statements) are really compatible with each other.

If we again take for granted, that history of science should be taught to students, there are still thorny questions to be answered, such as the following: (1) *In which way should the history of science be taught?* Is it always as successful as we find it described in enthusiastic reports of actual teaching experiences? Or are there failures and for what reasons? Are these difficulties considered for their own sake and where? Who should study these issues? (2) *What concrete opportunities exist for teaching or using history of science (or both)?* Indeed while they are opportunities that are clearly indicated in official curricula<sup>15</sup>, there are many others (in fact, the majority of them) which are not officially indicated but which are, in fact, excellent opportunities to introduce a historical perspective. What are these opportunities and how do they come to be recognized as such?

Finally, this issue should be considered, which, in a sense, summarizes many of the questions stated above:

*Concerning the question whether history and epistemology of science should be considered as a necessary element of one's culture (either student or teacher):* as far as teachers are concerned, what *culture* do we speak about? Namely, their *personal* or *professional* culture? The question may sound completely artificial, since obviously a teacher is (and should be) first of all a person, despite the natural tendency, especially among many people in charge of teacher training and careers to assume a teacher is (and should be) first of all a competent professional and, on top of that, a person who is already more or less cultivated. Whatever we may think about this Kantian dilemma in general, the concrete question arises, how one may convince someone who thinks on pure 'professional' terms.

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<sup>15</sup>The *tarte à la crème* example is the study of the law of free fall, for which it is rare not to see some encouragement to study Galileo's writings, or at least experiences.

### 3 THE STRATEGY WE SUGGEST TO CONFRONT THESE ISSUES

Given the questions, let us now summarize some possible answers that have arisen from ReForEHST discussions. Among other ideas, we have soon reached the conclusion that there is little hope to confront many of the difficulties indicated above if we are not ultimately capable of arguing for either the *necessity* or at least for the immense *usefulness* of history of science in addressing the difficulties or necessities inherent in teacher training. In other words, in order to develop an efficient and convincing argument for history of science, it seems preferable *not* to argue in the first place for the intrinsic value of the latter, but to begin with the necessities of teacher training and *then* to advocate the necessity or usefulness of history of science. Indeed, the first line of argument in general only convinces those already convinced; the second is liable to touch a much wider audience.

Therefore, the general line of argumentation and action we suggest is, in outline, the following:

- The first step is to establish as our point of departure the analysis of official instructions as well as the present state of teachers' needs;
- The second step is to show that, given a problem or request, history of science *is* or *should be* part of the answer;
- The third step is to show, through the analysis and diffusion of actual examples and experience, that history of science *indeed helps* to confront the difficulties analyzed in the first place;
- The last, complementary step is to demonstrate the necessity of time, experimentation, reflection and, therefore, of research.

The second step is more on the side of necessity, and the third of usefulness. They may both developed or at least one of them, considering the question raised initially. Let us now illustrate this general strategy of argumentation and research with respect to a few concrete examples:

1. One basic necessity of *young* teachers training is to help them becoming conscious of their role and place within the institution. Part of this problem is to give them means to appropriate for themselves the official recommendations they are meant to 'apply'. Nevertheless, Emile Durkheim long ago pointed out that, for many reasons, it is not enough, when one welcomes new teachers in the educational institution, to explain the official instructions they are meant to follow. First, these instructions are not always consistent with each other or with the concrete constraints of current teaching conditions or with the local *milieu*; often they deliberately *avoid* details on content and methods, so as to leave room for the teachers' creativity. Secondly, they sometimes propose activities or contents that are more or less remote from those the teachers experienced themselves as students, so that they must teach something for which they have no experience. Finally official instructions are oriented such that may raise philosophical or political issues and/or enter in conflict with the teachers' own ethical commitments.

Durkheim's own solution to these difficulties, which still remains valid today, was to propose future teachers *to reflect on the history of education* so as to understand *whence* come the present state of the educational institutions and of their leading principles, by making out the questions, debates and necessities that *produced* this situation. Durkheim's idea was not, of course, to propose a deterministic history of education that would explain the present situation, but one that would provide future teachers a 'field' to develop their

own critical reflections on the institution to which they have to contribute. The point is rather to make them conscious partakers in a complex tradition.<sup>16</sup>

2. How to help teachers to teach in a way which is different, sometimes very different, from the way they have learnt? Let us take for example the case of students' learning mathematics through problem solving — on which many modern mathematics curricula put a heavy emphasis. For some teachers, this may appear as a regression from a time in which more emphasis was put on imparting mathematical knowledge to the students; for many others, who are not hostile *a priori* to the idea and even sympathetic to it, this still represents poses a difficulty since they themselves have not learnt by solving series of problems, but by learning general theories to be applied to particular cases.

One way to confront these difficulties is to make teachers aware that problem-solving considered as a central feature of mathematical activity may perhaps appear as a novelty, but is actually not new at all when seen in the context of the history of mathematics: from the Mesopotamians and ancient Chinese or Indian calculators to the medieval abacus treatises, mathematics has been learnt, taught and presented through problem solving. In other words, many 'novelties' of the modern curricula, with respect to the teachers' own training, actually represent the resurgence of older and half-forgotten traditions. Generally speaking, the long-term tradition of scientific methods represent a far wider field, in terms of contents and methods, than the narrow body of knowledge learnt by even a talented person in his student years: to learn about this wide, forgotten field enables him to widen his understanding of his discipline as well as the relation between his discipline and other fields.

3. How to help teachers become aware of certain pedagogical difficulties faced by their students? It has become quite a commonplace, in mathematical education research, to compare the difficulties met by today's science students in learning such and such notion or such and such theories with the difficulties met by leading scientists in the time of discovery. But this only *becomes* a commonplace once someone learns about past discoveries and difficulties met during history. To explore and learn about the history of one's discipline, beyond giving a bare knowledge of half-forgotten theories or methods, as we have seen above, also helps to conceive in a more sympathetic manner the learning process in which students are engaged. If for example a student draws a finite segment and recognizes it as a straight line, his teacher might well point out that this was Euclid's way of thinking about 'straight lines' whereas *infinite* straight lines such as those our students are now taught to imagine were born much later in response to much more sophisticated concerns than those of elementary geometry. The modern student's difficulty is thus a 'real' one, in the sense that it corresponds to a very long history — but this only becomes 'real' when the teacher is simply aware that such a history lies behind his difficulty, and not just the student's apparent cognitive incapacity.

4. In modern curricula for almost all disciplines much emphasis is placed on helping students become good 'citizens'. While everyone would easily recognize that, in a wide sense, schooling should indeed prepare one for his future life in society as well as in the private sphere, there are still obviously divergent views about what 'being a citizen' (and, hence, becoming a 'citizen') means: is it (for example) becoming a 'cultivated man' capable of thinking and acting by himself, following the humanist ideal; or rather a citizen in the sense of someone careful of his health, his social and natural environment? Or rather a *politikon zoion* capable of partaking in the political life of a modern, democratic state? Or a man developing his own knowledge and critical thinking along with his knowledge of the world? Whatever answer one favors, it is easy to recognize that the modern issue of 'citizenship' within educational curricula bridges between these various aspects. Knowing about these

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<sup>16</sup>Durkheim's idea are developed in his famous book (Durkheim, 1999) available in English (Durkheim, 2006).

various views is of course essential for modern teachers, so that they can draw their own conclusions about the question — this refers us back to the first issue.

But beyond these general concerns on which he should reflect on a sound, historical basis, there is also the question of method: if, for example, one considers the meaning of ‘citizenship’ as ‘developing one’s own critical thinking’, how should or could this be done? There is now, for example, much emphasis but in modern *science* curricula on having students debate and argue issues with each other — very often the ultimate aim of such procedures is to develop the students’ thinking, but this does not mean that a science teacher would know how to proceed in order that such ‘debates’ effectively lead to this end and not just to empty arguing. This difficulty relates in some way to the second issue: many science teachers, when they were students, were not encouraged to argue in the classroom and had later no occasion to experience what is a debate in a scholastic, ‘serious’ sense: that is, a scholastic exercise with precise rules. Such exercises, on the other hand, have developed over a long period of history, and knowing this is a means to develop one’s own professional thinking and methods.

5. One modern concern, which is closely related to the previous one, is about getting students to a minimal mastery of both native and expert *languages*. But this again raises the questions of *why* and *how?*, especially for science teachers not also trained as language teachers (or who do see this as foreign to their job). Why should learning language and the ability to ‘speak well’ should be considered as essential to the development of one’s thinking? This classical question engages much philosophy and knowledge of the history of education – but again this only becomes a ‘classical’ question once future or present teachers become aware of the underlying history. Similarly, the way in which language should be cultivated within the classroom requires a minimal awareness of the exercises which help do so: while many of these exercises are common knowledge for language teachers, so that collaboration of science and language teachers is an obvious approach, learning history and becoming aware of ancient scientists’ own concern for natural and expert languages is also a powerful mean to develop the teacher’s reflection on this field. To take one example, ancient mathematicians, such as the third century Chinese mathematician Lui Hui, were well aware that one has to verbalize algorithms to understand their meaning and scope: if you have, for instance, special names, like ‘denominator’ and ‘numerator’ for the fractions algorithms, this makes a huge difference, in terms of understanding, as opposed to a state in which you only know how to calculate.<sup>17</sup> This aspect of learning algorithms is only understood when ones reflects about the language and its deep impact on learning and, in this case, understanding algorithms.

#### 4 4 THE PROSPECTS OF THE REFOREHST INITIATIVE

The previous developments give the reader an idea of some key issues the ReForEHST meetings and publications have helped to formulate, as well as a strategy to confront them. On a mere practical level, it is very difficult by now to make long-term plans for this initiative, given the uncertainties of the present French situation as far as teacher training is concerned. The IUFM are now undergoing a process of deeper integration to local universities, which implies some important changes in status, financial support and organization. This is accompanied by clarification of the aims and ends of the teacher training system. This clarification, as far as history and epistemology is concerned, seems to go in a good direction, since the official recommendations insist that any future teacher should be aware of didactic, epistemological and historical issues concerning his discipline. On the other hand, the present development of the educational institutions obviously occur against the background of budgetary restrictions that may imply, at some stage, difficult decisions in which history and epistemology may not appear as a priority. Whatever the outcome of this complex evolution, which is filled with

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<sup>17</sup>On this particular question we refer the reader back to Chemla’s and Guo’s recent translation of the Nine Chapters, Dunod 2004 (see esp. their remarks on ch. 1).

uncertainties, we will explain here what we will attempt to do in the immediate future and on a long-term perspective, in continuation with our previous initiatives.

In the immediate future, we are working to build in France a research team, with an official status, working on the issues mentioned above. Indeed the ReForEHST group, to this day, has worked as an informal assembly constituted of ‘hommes de bonne volonté’, as Jules Romain would have put it. But it has received neither official recognition nor, for that reason, any serious financial support. We are thus working on a more detailed project that would solve the old dilemma of being married yet remaining (reasonably) free; that is, a project that may help us to acquire a more ‘recognizable’ identity, without losing, if possible, all the advantages, flexibility and ‘freshness of mind’ which are proper to an informal group. In parallel, we are trying to promote the same issues at the European level by taking advantage of the recent discussions on these issues promoted by the European society for history of science. We have participated in these discussion at the Cracow meeting in 2006 (Guedj, Laubé 2006) and will propose a workshop on the same issues at the Vienna meeting in Sept 2008.

Generally speaking, we wish to continue to organize meetings, if possible on a one-year basis so as to keep alive the momentum created by our previous initiatives. These meetings are very important because they offer an important occasion for isolated colleagues working on the same issues to come into contact with us. It also makes a lot to inform a wider audience on our action and purpose. We also hope to continue more intensive research and training activities related to our key issues by taking advantage of any framework that may adapted to this development.

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