

# “Science Academie”: Raising Scientific Passions and Fostering a New Social Link

Livio RIBOLI-SASCO<sup>a</sup>, Alice RICHARD<sup>a</sup> and François TADDEI<sup>b</sup>

<sup>a</sup>*Ecole Normale Supérieure, Paris, France*

<sup>b</sup>*INSERM, institut Necker, Paris, France*

**Abstract.** Science education in French schools today is suffering from two major problems. Less and less students are enrolling on science courses while obstacles caused by unequal opportunity make it increasingly difficult for less privileged learners to obtain high standard university places and to embark on scientific careers. The way science is taught in schools in France (heavily weighed down by theory and desperately lacking in practical content) urgently needs changing if it is to be made more appealing. It is now time for researchers to collaborate with schools to show that science can be pleasantly challenging and fascinating. Above all, a fundamental reason why science education must be improved is because citizen respect and interaction are fostered through the study of science. Everyone today is directly concerned by scientific issues. In a society where science encompasses more and more ethical questions, a common basis of scientific knowledge must be shared amongst each and every one of us. We would like to prompt researchers into showing that science can be made enjoyable, thereby inspiring students who suffer from a social disadvantage and then to offer our support to the keenest students in order to help them become talented scientists. Helping them to belong to a broad network and training them in scientific vulgarization will help us inoculate a “Science virus” in schools and on a broader basis in society. By intervening locally, with a global approach, changes can be made on a broad scale, i.e. National or European, provoking a cascade of changes in the educational system leading to what could be called a new “equilibrium” of education.

**Keywords.** Network, Science, Education, Society

## Introduction

In November 2005, riots broke out and spread rapidly throughout French suburbs, reaching unprecedented levels of violence. How can we account for this irruption of violence? Obviously there is no clear answer. There was no distinct political message, only a total rejection of a society that wasn't able to integrate immigrant children. These children were living in dilapidated buildings, they were finding it increasingly difficult to study or find employment and had nothing to hope for in the future. One incident holding high symbolic potential was enough to spark off an epidemic of violence.

It is in this social context that researchers and university students decided to set up a program that would open the doors of science and research to the disadvantaged youth. This simple course of action might seem inappropriate in face of such serious and widespread social problems. Yet we believe that initiatives inspired by the Hungarian Kut Diak movement can be at the source of large-scale changes covering an area way beyond sciences.

## **1. Science Education in France in 2006**

### *1.1 An increasing lack of interest for scientific university studies.*

According to the report « What should be done for schools in French suburbs » published by the « Institut Montaigne », 40% of the students living in so called “Sensitive areas” leave school without any qualifications. In addition to this, the number of students entering university to study Science fell by 32% between 1995/1996 and 1999/2000. Sciences have become increasingly unpopular amongst students at school, and in particular towards the most disadvantaged. This situation is alarming. Researchers must get involved quickly in order to spread a new attractive image of Science and to battle against the inequities of our educational system. Enthusiasm and passion are essential characteristics of good scientists which can be easily transmitted to encourage students in choosing scientific studies . Political and educational institutions do not realise just how grave the situation is. This is another reason why researchers should get involved.

### *1.2 Unequal opportunity to study science at university and higher education establishments.*

Some talented and creative teenagers do not even apply for the university best courses as they believe they will not be able to afford the cost of long studies and that these studies are reserved for social elite. These difficulties are emphasized by the dual French system, divided between universities and “grandes écoles”. Any high school student can apply for a place at university in France, without having to go through a process of selection, whereas “grandes écoles” recruit through highly selective competition, after two years of preparation. In order to be given an opportunity to prepare for competitive exams, students must present an excellent school track record.

Universities are allocated a third of the budget provided to “grandes écoles”. Ill reputation, combined with appalling results and student self censorship keep a great number of students at bay from the classes which prepare for the competitive exams leading to “grandes écoles”. Thus, a social division takes place at the end of high school. The “grandes écoles” usually train their students up to Masters degrees. Afterwards some of these very bright students move to universities and start a PhD, preventing most university students to access PhD programs. French higher education

system is completely partitioned. Every year, the amount of students that come from working class and immigrant backgrounds decreases.

However, scientific research comes to be more creative and productive with people's diversity. The contribution of international or interdisciplinary collaboration towards innovation in research can be easily understood. We would like to encourage greater diversity emerging from a variety of social and cultural backgrounds. All the different social communities have to be represented. In that way, it will be easier to pay attention to all the questions emerging in our society and that have to be translated by scientists into research programs.

In addition to this, scientific professions are a symbol of social success. To those recently immigrated in France, those who suffer from discrimination or from living in disadvantaged areas, science and research can offer a chance to climb the social ladder and a bright future. Allowing a real equality of opportunity in accessing academic professions is a way to eradicate many prejudices. Intelligence is not confined to any social or ethnic group but is shared amongst all. Enabling social ascension through science contributes to social cohesion. People from different origins form an important community committed to a public mission for scientific progress.

### *1.3 Science is not a research experience...*

For many children, from primary to high school, scientific education will remain an isolated experience. Very few of them will remember and consider this education as useful in their adult life. Scientific education is often reduced to a corpus of theoretical knowledge. Practical experiments are rarely carried out and in any case limited to a mere demonstration of what has been already taught. It is thus impossible for the students to discover and build any scientific reasoning and argumentation. If learners at school cannot discover for themselves, working on a step by step basis, it is difficult to make science and scientific careers sufficiently attractive to incite students to find the energy and motivation needed to succeed in long and demanding studies. In the same way, musical studies are long and difficult. It is obvious that it is nearly impossible to succeed without being passionate about music. It's the same with sciences [1]. This way of teaching science can be explained through an analysis of the purpose of French education at its origins. Schools have been developed and widespread all over the territory at the end of the 19th century in order to build a nation, a community of language, values and knowledge. School has not been intended to develop creativity. Our social values have changed, and we now need emotion, passion and self-development to lead some students to scientific studies.

Obviously, not all students have to be encouraged to choose scientific careers. Yet, scientific education in high school will influence many generations of future citizens who will have to tackle technological, scientific and ethical questions. Gloomy chemistry courses combined with an increasing awareness of pollution problems (some of them due to chemical industry) may induce a global rejection of chemistry as a science subject as well. Improving scientific education and privileging education using research methods is essential to train mature citizens, well informed on the scientific world and its importance for society.

### *1.4 Lack of teachers training to sciences and pedagogy*

Teachers from primary to high school cannot carry out research as well as teach in schools,

although some of them have experienced research in their early years when they were students at university. This deep division between teaching and research contributes to convey a biased image of science and research in schools. The scientific knowledge transmitted to students is never shown as an evolving knowledge, rich of a lively history, full of controversial theories that are soon falsified. It is urgent to reconnect the two worlds of research and education. Indeed, the student, as the researcher, tries to learn by himself, observing and then setting up theories and experimenting new ideas and explanations. Students and researchers may have more in common than students and teachers. We could advocate the “ignorance” of the teacher, as suggested by philosopher Jacques Rancière. “Ignorant”, the teacher is placed in the same learning process as the student. His knowledge is related to the method that has to be followed in order to discover and learn. Indeed Jacques Rancière gives evidence of such a process, showing us a group of student, helped by their ignorant teacher, all of them learning together a new language: Flemish.

## **2. Why teach Science?**

All the above mentioned difficulties only emphasize the potential of first-rate scientific studies. Sciences strengthen the sense of citizenship; they prepare young people to face future challenges; and for some students they can offer a solid social ascension and integration. This potential of scientific education is completely underestimated. In order to make the most of it, we would have to rethink globally the way we deal with sciences at school.

### *2.1 Science conveys values: questioning the world, going always deeper in reasoning, respecting other people's words and thoughts.*

As for all subjects taught at school, science conveys values. It insists on observation, reasoning, experimentation, deduction. It allows for dialogue and tolerance. Indeed, science is a constant dialogue between researchers, between disciplines, between different opinions, all of them supported by accurate arguments. Science appears to be an ideal training to citizenship, at a time when school content itself with little information on the history and functioning of our institutions. Practicing a scientific approach at school enables young people to make sound choices later on and to avoid being caught by blinding ideologies.

### *2.2 Innovation, resilience*

Young generations, currently in our schools, will have to face major challenges (climate change, ethical choices, international conflicts, etc.). We must take into account the fact that these young people are living in a world overloaded with information transmitted by various media. In that context it is essential to sharpen their critical mind. We have to train them to distinguish the true and the false in an easily available mass of information. Scientific process goes from observation to theorization; all along information recovered from experimentation or observation is transformed into useful knowledge. Going further, this knowledge can be a source for innovation

and action. We also formulate the hypothesis that a widely shared knowledge is a source of resilience for our social system. In other words, these systems would be better prepared to political, economical or ecological disruptions.

### **3. Scientific solidarity?**

#### *3.1 Paris Montagne : a Science Festival*

Paris Montagne Association was created in January 2006, one month after violent riots broke out in French suburbs. Students and researchers at the Ecole Normale Supérieure wished to share their passion for science and let others discover the world of research. This association set itself the task to contribute in bringing young students from underprivileged backgrounds to scientific studies by fighting auto-censorship towards long studies at university or in “grandes écoles”. It offers individual mentoring and financial support (grants). In addition to individual support, Paris Montagne offers collective support through local intervention in underprivileged high-schools. We try to trigger positive dynamics through “science clubs” which are directly set up by young students that have been previously trained. Paris Montagne supports reflection and research on educational topics, pedagogy and didactic.

Paris Montagne organizes annually a summer science festival on the Montagne Sainte-Geneviève (Paris) and entertains a wide audience, coming from disadvantaged suburbs near Paris. This festival takes place in the “scientific campus” of Paris that is to say the Latin quarter. This festival has a social perspective. Showing science through a huge festival, through pleasure, is a way to open it widely. It’s a way to reconcile adults with science; theatre, funny experiments are a powerful therapy. For younger ones it’s a way to discover a new face of Science (different from the scholar one), and to meet the challenge brought to them by researchers.

#### *3.2 PM & Science Ac’ 2006 : at least a starting point*

Paris Montagne also works on a long term basis with high school students, and with the students belonging to the “Science Académie” program (inspired by the Hungarian Kut Diak program) in particular. These students are selected at the end of their first or second year of high school. Two main criteria have been used to carry out their selection: their motivation towards sciences and the handicap created by their social background (immigrant families, profession of parents, underprivileged schools, number of brother and sisters)... The application forms were diffused in Parisian suburbs. In 2007, we hope we will be able to get in touch with all French high schools.

It is through these high school students that the association hopes to have the greatest impact possible as far as the goals it has set to itself are concerned. We hope to support them in their studies and to offer them all the chances they need to reach quality training and a scientific career. Moreover, these students will set an example to other pupils, proving that “science is possible”.

These students are not selected according to their marks at school, and we bet that at the age they are at, nurtured passion for science can lead them to scientific excellence. To bid on young talents is all the more important as creativity and scientific productivity during the first years of work create an advantage that remains during an entire career. Simonton (1991), followed by Stephan and Levin (1992) showed that

most exceptional scientists had a high scientific creativity and productivity, that remains steady and then decreases slowly, whereas for a medium range scientist no increase is ever observed.

Paris Montagne offers to the young high school students a new concept of training and support. During the Festival “Paris Montagne : le Pari des Science” they take part in a week of training, supervised by high level researchers and PhD students. They become familiar with scientific questions and with the daily working life of researchers. They also learn how to write a project. They conceive and realize a whole experimental protocol during the week. They visit many laboratories belonging to the most important scientific institutions (Ecole normale supérieure, Institut Curie, ESPCI, Collège de France, Universities). They make a first step into a network that will link, in the long term, high school students, talented researchers and students. This network is sponsored by the French Academy of Science and reaches out to Hungary and Croatia. It provides a daily support for the studies, but above all offers the possibility of short internship in the best laboratories.

On the occasion of the Paris Montagne Festival, these young students gain self-confidence as they are trained to scientific communication. On this basis they will be able to animate sciences clubs in their high schools, with the coaching of professional associations. They will diffuse their passion for science, and will appear as an example of success in their schools and in their social environment. Eventually they will break down some barriers in our societies.

### *3.3 What could be a Tipping Point in Science education? Would it also be a Social Tipping Point?*

Facing the various reports dealing with the state of scientific education and considering the objectives that we set, some might think the next step is to reconsider the education system overall. However, it is not necessary to be a fine political analyst to know that full and radical reforms are difficult to implement. Anyway, as we are not politicians, these reforms are not within our competence. We think however that local action, concerning a small number of individuals as what we propose with Science Academy, can be at the origin of major changes.

An event such as Science Academy comprises several strong points:

- Recruitment of young people with a passion for science and a strong capacity to communicate and convince.
- High quality training during a week in the best French ‘Grande Ecole’
- Meeting point for people with a strong “connection” potential

These three aspects take root in the concepts developed by Malcolm Gladwell in *The Tipping Point* in the chapter *The Law of the Few*. These young people could be at the origin of an "epidemic" diffusion of a new passion for sciences. This passion and the development of their capacities of communication during their stay at the Ecole Normale Supérieure make them good "Salesmen". Without a doubt some of them will be able to encourage their comrades to gain confidence and lead them towards scientific studies. The Science Clubs which they will set up in their high schools will reinforce this collective positive attitude towards science. They will show that being invested in Sciences offers knowledge and perspicacity and that it makes studies more

meaningful at a time when sport and music are often much more important than all the topics studied at school... As they start belonging to a network of passionate young people and researchers, they will be able to connect more people and to diffuse a innovating approach of Sciences. Thus, an action currently limited to 21 young people has the extraordinary potential to affect many more of them.

Another dimension of our action is related to the choice of anchoring the Science Academy training week into the Science Festival, that is to say at the heart of a politically visible event taking place in the best French “Grande Ecole”. This allows us to act on two aspects: to inoculate a virus of Sciences amongst young people and to open a dialogue with politicians and society at large by means of the media. Indeed, why would we direct these young students towards sciences if at the same time scientific professions lose value? In the last years French research has lost a lot of its public financial support and wages remain low. It is important to reaffirm the economic value of research, its contribution to innovation. Paris Montagne also tries to demonstrate the educational importance of Science. Scientific professions should not be a goal for all students but by studying science at school students can develop intellectual skills required for reasoning and interaction.

In the long run, this Science Academy can encourage teachers to reconsider their practice. Stimulation towards innovating teaching methods can emerge from such an approach. Mutual education can take place between students: through cooperation and collaboration, peers can share their knowledge and build upon each other’s. Indeed we incite the students we train to transmit their passions, their knowledge, to share their discovery of a world that few of them know, that is the world of research. The exchange of information between young people, which can be observed as early as in primary school [2], is completely unexploited in the traditional education system.

Overall, this kind of exchange of knowledge is a factor of social cohesion. Everyone has only limited knowledge and competence, even with high level general training. However all along life, each one of us needs a wider range of skills and greater knowledge. Setting up networks which allow to exchange information and ideas making it possible to diffuse knowledge and share skills within a social network. Science Academy is a starting point to create such networks in high schools by connecting people eager to acquire some sort of knowledge and/or carrying other sorts of knowledge.

#### **4. International perspectives.**

##### *4.1 Emergence conditions.*

Some characteristics of the system developed in France, inspired by the Hungarian program Kut Diak, can be used in other countries. The transposable characteristics are those related to the propagation of a new approach to sciences, to the setting up of a network linking young people amongst themselves and with the world of science and research. However one should not forget that this program was set up in a very particular French social and political context. These conditions of emergence cannot be reproduced and it is important to listen to social requests and to analyze which would be the optimal conditions for such a program, elsewhere in Europe. Politicians must be made to be aware of the stakes of such a program. To reaffirm the importance of investing money in sciences (research and formation) is a crucial long-term task that

scientists must undertake. Should a political or social crisis occur we should dare to demand additional investments, even if these investments may seem superfluous in comparison to more concrete forms of actions. Indeed, our experience shows that side actions can tip up a situation. Politicians seldom measure the complex nature of the dynamic of social systems... scientists and in particular ecologists might help them to understand this complexity.

#### *4.2 Create a basic network on a European scale rather than interconnected national network*

Members of Science Academy are currently building a solid network, bridging high schools and universities. This is also true in Hungary, which is already ahead, this type of program having been initiated ten years ago. Extending this program to other European countries can be done by following two paths: connecting networks or designing a global network directly on a European scale. It would be useless to point out here the importance of students' mobility or to stress the success of exchange programs such as Erasmus. We should evaluate the potential of a program similar to Erasmus but focused on 15-18 year old students. A program which would go beyond mobility since it would put in contact young people eager to share a common passion, maintaining a nourished contact between various generations, in various countries. Baring in mind the social dimension of scientific education, we can perceive the potential of such a European network.

The example of an "international high school campus" such as the one set up in Lyon since 1991, that gathers in the same building (symbolically placed where two rivers join) children from 6 to 18 years coming from over forty countries, reinforces these assumptions. Cohabitation of several languages, different geographic and social origins, in a context combining intellectual emulation with the will to encourage students to become more responsible for their actions (the management of the establishment is shared between students, teachers and administration) leads to top ranking scholar results. The children are motivated, share their knowledge, their cultures, learn how to respect each other, whatever their social or ethnic origin. Science is by definition international. Today it opens itself to young people; it must seize the opportunity to open internationally towards European youth.

### **Conclusion**

The situation of French scientific education from primary school to high-school is neither brilliant nor catastrophic. Many difficulties remain on the pedagogic level. We suffer from too many students dropping out of the sciences and strong social inequalities in gaining access to high level studies. Major reforms should be undertaken. Facing this huge and difficult task, we choose targeted, inexpensive actions with a strong diffusion potential.

Amongst young people, fashions propagate quicker and quicker, with evolving communication technologies. We bet that Sciences could become a new craze which would diffuse suddenly among young people. We try this through Science Academy, with its provocative name, picked from a television program, the "Star Academy" transforming young people into stars through music and television. Our bet isn't very academic, but our world isn't either...

We wish this project to be followed up in the long run, and that possible social changes will be seriously studied. We must launch research programs studying how education can structure social relations between young people of the same age and social relations in our society at large. Young students, who know how to interact about scientific topics, may establish in the future specific social interactions... surely different from the interaction induced by a typical teacher/pupil relationship.

Reconsidering our educational programmes to favour interaction between young students and Science at a European scale could add a new profitable dimension of exchange and sharing between nations, of mutual enrichment for Europe. Perhaps we won't manage to fulfil all these objectives. The few young people already motivated in Hungary and now in France are fully determined to take over from us and to reach this objective.

## References

- [1] R-E. Eastes, La chimie : du solfège à la mélomanie, L'influence de l'enseignement de la chimie sur son image publique, *L'Actualité Chimique* **297** (2006) 38-43.
- [2] L. Riboli-Sasco, R-E. Eastes, F. Pellaud, J. Capelle, E. Sabuncu, L'effet récré, ou l'application à la didactique des théories évolutives de la propagation des idées, Actes des XXVIIèmes JIES, 2005