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An abstract image showing a hand on the left interacting with glowing, ethereal blue and pink energy lines that flow across a dark background. The lines have a liquid, smoke-like quality. On the right, there is a glowing pink, bulbous shape resembling a neuron or a cell. The overall aesthetic is futuristic and scientific.

education
**reinventing
science education**

research*eu is the European Union's research magazine, written by independent professional journalists, which aims to broaden the democratic debate between science and society. It presents and analyses projects, results and initiatives through which men and women are making a contribution towards reinforcing and uniting scientific and technological excellence in Europe. Published in English, French, German and Spanish, with ten issues per year, research*eu is edited by the Communication Unit of the European Commission's Directorate-General for Research.

The missing link

The articles in this special issue discuss various European views and original experiences of science education. These are of interest because they are, educationally and geographically speaking, both far removed from, and complementary to, so-called 'classical' methods. In parallel with the education provided by schools, these initiatives are taking place in informal contexts, providing every individual with the opportunity to express him or herself, experiment and "get it wrong".

But we will be very careful here to avoid painting a black and white picture of the proponents. Although this issue is primarily devoted to these new approaches, don't see it as an implicit criticism of education, or of its rigorous, even austere approach, to the sciences. See it rather as a celebration of the organisations that practise them in the most attractive and entertaining ways. We should not be sidetracked by pitting one teaching method against another, finding one out-of-date and obsolete, and regarding the other as the 'right' way to do things. Instead we should strengthen how they complement one another. In science, thoroughness and inconsequentiality, calculations and emotions, knowledge and interactivity, *tekhnē* and *logos*, can and must go hand-in-hand. This can be encouraged by accentuating the links between classical and innovative approaches to science. How many children visit a museum or a science centre at least once a year? One encouraging sign is the increase in the number of visits recorded by the 2005 Eurobarometer study.

It is perhaps scientists who should be the first to speak out and show the way. By reminding us of, and reinforcing, the fact that communication is also a science. The position taken by high-energy physicist Michel Crozon is exemplary in this regard, and unfortunately far too rare: "I popularise what I do in order to understand it better". If young people reject scientific and technical opportunities, it is undoubtedly less because of school programmes than because of the image of science, which is generally conveyed as being laborious and mechanised, or even dehumanised.



Michel Claessens
Editor in chief

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Run by Norway, spanning three continents and 16 countries, the Mar-Eco project

Getting to grips with science

In today's knowledge-based society, science and technology (S&T), as we are being constantly reminded, have become an integral part of our everyday lives. Could it then be because of its close proximity to us that the image of science seems tarnished and its exploits no longer heroic? This appears to be the case in the most developed countries, where the next generation is turning its back on S&T subjects at school – and even more so when choosing careers. Even if these observations are open for discussion, the results of various studies (Eurobarometer, Pisa, Rose, TIMSS) have confirmed the trend.

This apparent lack of interest in S&T is undoubtedly a cause for concern not just for educational authorities, teachers, research and scientific centres, and those working in informal education, but also for actors from business and industry. So what are the causes of this indifference to S&T and how best can they be remedied?

At European level, for example, *Eurydice*, an EU funded education network, analysed science teaching in 30 countries⁽¹⁾. The authors of the report focus particularly on teacher training, school programmes and standardised student evaluations. They look at those who train science teachers, pointing out that the 'question underlying the data presented here is what regulations are defined at central level and whether these have much to say about what teachers should know and what they should be able to do'. They also ask 'how do they develop innovative approaches and procedures?', and question 'the development of scientific ways of thinking by and for teachers themselves'.

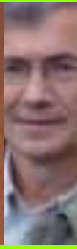
The *Rocard group*, appointed by the European Commission, recommends a radical change in the teaching of science (see page 10). This special issue features projects aimed at providing educational support to teachers, who often become scapegoats in the debate on

education. A number of initiatives, several of which have been set up by major, trans-European scientific centres within the framework of *EIROforum* (pages 38-42), deal with teacher training, while other projects focus on establishing networks of educational activities (*Ecsite*, *Xplora*, *Pencil*, *Pollen*). Also featured are some examples of projects from museums and science centres (Barcelona, London, Bordeaux and Naples), where an informal educational approach has been taken to complement traditional forms of teaching. As for universities and researchers, several initiatives are showcased which demonstrate that academia has plenty of imagination when it comes to working with schools, as well as with larger audiences (*Mar-Eco*, 'climaTIC-suisse').

In addition to the abundance of initiatives aimed at reawakening a taste for science, the causes of any indifference and/or disenchantment need to be addressed. Decoding the enormous ROSE study on the relevance of science education (page 7), Svein Sjøberg and Camilla Schreiner move on to the emergence of "youth culture" in industrialised countries, and examine the images and values it conveys. They also point to the problem of democratic participation and the importance – for everyone – of understanding the impact that S&T has on the way we look at the world and live our lives. These issues also guide the approach taken by Luigi Amodio in his work as director of the *Città della Scienza* (page 30).

Even if society has started to question and critically examine science more, this does not mean, fortunately, that it is less interested in the debate on the challenges and issues of scientific research. In order to be convinced of this, it suffices to spend a lively evening at a *Science Café* in Nijmegen (NL), where two very experienced physicists, Gerard 't Hooft (Nobel 1999) and Robbert Dijkgraaf, enthral the crowd with a topic as abstract as string theory (page 32), or to listen to some of what other science enthusiasts – whether they don a white coat or not (page 6) – have to say about their work as researchers (page 20). ●

(1) *Science teaching in schools in Europe. Policies and research, 2006* – ISBN 92-79-01922-8 – Available in French and English – www.eurydice.org.



A question of image

"Scientific advances (particularly in the biotechnologies and genetic engineering, the areas most often focused on by the media) revolutionise our understanding of the living world, just as the concepts and representations formulated and forged during a slow process, throughout history, enable us to perceive and think of ourselves as human beings. The challenge is to redefine what this 'humanity' means by understanding it and perceiving it through scientific discoveries."

Bernard Schiele

*Professor at the University
of Québec in Montréal*



The two sides of Howy

Howard Jacobs – “A change of environment is a catalyst for renewed research.”

Picture this: Prague Castle, 2 December 2004, the Descartes Prize awards ceremony.

The audience whispers and casts sidelong glances as a man, sporting a shaved head and Tintin tuft, and wearing a kilt, stands up to accept an award. They ask: who is this man? Why, it is Howard Jacobs, of course, biochemist and winner of the fifth annual Descartes Prize for his work as coordinator of the MBAD (Mitochondrial Biogenesis, Ageing and Disease) project.

Some might call it scientific eccentricity or British anti-conformity, but for Howy (as his students like to call him) the kilt and the punk haircut are nothing more than symbols of his faithfulness to himself. ‘It struck me as the perfect evening wear for a punk, which is what I am, who spent 15 years of his life in Scotland.’

Future + no future

Flashback. The year is 1977 and Howard Jacobs is 22 years old. He has just completed his studies in biochemistry at the University of Cambridge (UK), where many decisive advances in the life sciences have been made. The head of his laboratory is Tim Hunt, who will go on to win the 2002 Nobel Prize for his work on cell cycle regulation. In the year that Jacobs graduates, Frederick Sanger will put the finishing touches to decoding the DNA

sequence of a bacterial virus. This will win him the Nobel, which was awarded in record time in 1980.

This is also the year that London is throbbing with the fury of the punk movement. But what does this great city of British science and the deafening nihilism of the ‘no future’ punk movement have in common? Well, these two opposing worlds will mark Howy’s life. Since genetic engineering, still in its infancy, thrills him as much as the punk counterculture, it would be impossible for Howy to choose between the two. Howard Jacobs begins to work on a thesis at the University of Glasgow but does not abandon the London punk underworld. He regularly leaves Scotland and hitchhikes to the concerts of his favourite groups. In 1981, Howy reaches a new turning point. He leaves for the United States, where he pursues his post-doctorate studies at the


California Institute of Technology, another Mecca for the young genetic engineer. Two years and a published article in *Nature* later, he returns to the University of Glasgow, where he will remain for more than 10 years.

Long-term research

In the middle of the 1990s, Howy is offered a position at the brand-new Institute of Medical Technology in Tampere, Finland (FI). He leaves the Scottish mists in 1996 for the wide expanses of Scandinavia that he loves so much. This is a new point of departure in the career of a man who has said that he is convinced that “a change of environment is a catalyst for renewed research”. As a great defender of European scientific cooperation, as long as it is based on ‘excellence’ and ‘openness to the outside’, he then becomes involved in transnational projects on the relationships between genetic mitochondrial mutations – the power plants of cells – and conditions such as deafness, masculine sterility and the pathologies linked to ageing. The discoveries made by his team of around 20 people include the linking of errors in mitochondrial DNA to the ageing of the body. “This lengthy work would have had little chance of being financed at national level, where it would probably have had to compete with research on cancer and cardiovascular illnesses.” And it is this research work which will go on to win Howy the 2004 Descartes Prize, worth one million euros.

So did this unusual-looking winner send shock waves through the heady atmosphere of Prague Castle? “I didn’t notice anything in particular. People take me as I am,” says Howy. Even so, in addition to speaking volumes about his personal taste, Howy’s choice of wardrobe also reveals a different take on culture and science. “To me, it seems to be very important that the public at large see and understand researchers who have different styles and attitudes. This reminds them that science is not a monolithic activity that demands uniform consensus. Besides, what could be more normal for a scientist than to be a rebel?”

Mikhail Stein

 www.miteuro.org
www.finmit.org/howy.htm



Svein Sjøberg



Camilla Schreiner

Values and choices

Young people are turning away from scientific studies and careers. Everyone deplores this fact. Svein Sjøberg, Professor of Education Sciences at the University of Oslo, and Camilla Schreiner, a young doctoral student working in the same field, give us their opinions on the hows and whys of this situation. The international ROSE (The Relevance of Science Education) Study, led by Norway for the past few years, supports their arguments. If we want to motivate students, we perhaps need to analyse what motivates them...

In 'advanced' countries, one particular observation is a cause of concern: young people are opting less and less for scientific studies and careers.

How do you explain this trend?

Svein Sjøberg: Let me turn this question around. Who says that we have to change this situation? For whom is young people's avoidance of S&T studies a problem? *Everybody* tells young people that the lack of scientists and engineers is a problem for

society. If this is the case, market forces could, for example, make these jobs more attractive and better paid. Alternatively, we could 'solve' this problem by importing young talents from Asia or elsewhere, as the United States does. Also, to be honest, the lack of recruitment is not a valid argument for young people. Youngsters do not choose their future careers on the basis of what (some) adults say is good for competitiveness or the economy of their country! And they also see that it is not the

scientists or engineers who get the best jobs. Besides, S&T studies may be hard and demanding, they require concentrated effort. Many other studies are easier, perhaps also more fun...

Camilla Schreiner: Youth is commonly seen as a time when people construct their identity. Young people express their identities through symbols such as clothing, leisure activities, taste in music, sports, school subject preferences, classroom behaviour, etc. Educational and professional choices are also seen as symbols communicating an identity. A designer or an actor has a different image to an engineer or a physicist.

Because of this background, pedagogy specialists – and sociologists – say that the traditional question of “what do you want to be when you grow up?” addresses a more far-reaching issue than before. Today, the answer should be seen less as a perception about a job or an income, and more as an answer to the question “who do you want to become?” When young people choose an education or a job, they simultaneously express important components of their identities.

But there seems to be a paradox, at least in many countries, between young people's interest in science – which is shown by many studies – and the choice to make a career of it.

S.S.: We need to make an important distinction here. Young learners are actually interested in S&T, but not so much in the S&T they meet in their school curriculum, which is traditionally



What we learn from ROSE

How do we improve science and technology studies? How do we encourage students to be more interested in them? From one continent and one country to another, what are the differences and commonalities in this area? Initiated by Norway, the impressive ROSE study reveals the current state of affairs. The study, carried out with 15-year-olds, is not limited to quantitative data but provides an in-depth look, thanks to interviews, at young peoples' expectations and values. The work is carried out by researchers in 43 countries on all the continents. Approximately 10 doctoral students are making it the topic of their thesis.

A transparent site provides access to the data, to the questionnaires, to the results by country, to the methods used and to a comparative study of the points of view of young people on science and education, as well as to a number of documents and analyses.

- based on well-established science that cannot be challenged – that even the philosophers of science call 'textbook science'.
- This is in stark contrast to the "real science", which scientists of today are engaged in, with its heated debates, new experiments, tentative hypotheses, conjectures and conclusions, etc. This is the 'research frontier', where new territories of knowledge are actively constructed by real people. This is often the kind of science that is reported (often misleadingly, however) in newspapers, TV programmes etc. Many youngsters love this kind of science – although they may hate school science.

Would it then be sufficient to change school curricula, to offer 'real' science and to get rid of encyclopaedic and 'fossilised' teaching?

S.S.: Yes, we do need to change and upgrade the S&T curricula. But this poses difficult

questions. On the one hand, we want school science to change and become more 'real'; on the other hand we cannot teach the latest advances without also providing the necessary tools to understand them. Ideally, we should revise the way we teach traditional basic knowledge. This knowledge is the Wisdom of Hindsight, when all dead ends are removed, when all the conflicts have been resolved, all the dust of heated discussions has settled. Such well-established science may seem boring, but it also provides a basis for a deeper understanding of current research.

Furthermore, addressing these 'new frontiers of science' at school requires great effort on the part of the teachers, few of whom are prepared to present these contemporary subjects.

Do we need to adapt teaching to reflect the ways that young generations think? What are the limits to an approach of this kind?

C.S.: Of course we cannot adapt the science curriculum to current trends in youth culture and the interests and values of the pupils. This is neither desirable nor possible. Rather, knowledge of young peoples' interests, priorities and concerns can be a means to create a link between the teaching of science and young people's lives. Being interested in pupils' values does not mean adopting those values, but they can be used to kick off discussions. The broad diversity of students' interests also offers teachers a wide range of avenues to engage pupils in scientific content and encourage them to reflect on their own opinions and priorities.

S.S.: Many of the items in our ROSE questionnaire would definitely not have a place in a serious science curriculum. Even so, some of them may be addressed in discussions about what is science and what is not science. To be able to distinguish science from pseudo-science is an important issue. So for example, a science curriculum could discuss astrology, homeopathy, divination, etc. Maybe even the links between science and religion. But treating such issues delicately, without offending people who believe in these systems, is not easy.

Does an evolution of this kind in teaching not run the risk of leading to lower requirements and to a drop in student

levels and hence of the students themselves?

S.S.: This is one of the many challenges. Perhaps we have to choose different methods, depending on the age and level of the pupils. When we have a general 'science for all' course, we need to find approaches that suit everybody, not only the future scientist, but also the future citizen, consumer and voter. At that level, we simply cannot present mini-versions of academic science. However, in the higher grades, when the students have made their own choices, we can certainly put more emphasis on the laws, theories and models of science.

The responses to the sentence, "I would like to become a scientist", asked on the ROSE Study questionnaire, are clearly more positive in Africa and Asia. Why?

S.S.: Differences should be treated with caution. In some countries, there is a tendency to agree to most assertions, in others not. We therefore often compare relative scores or residual scores, where we look at the data in a different way.

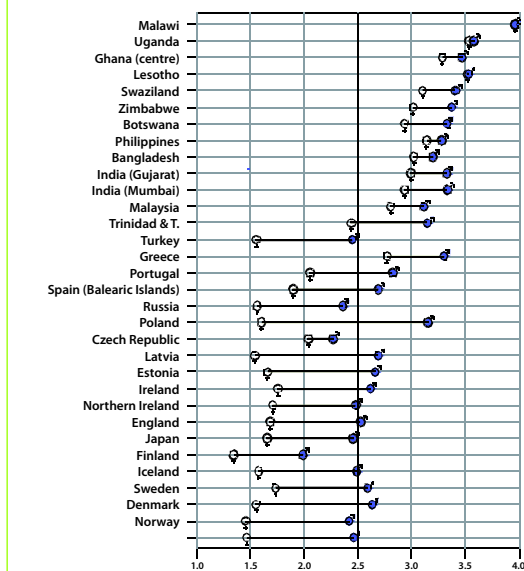
In particular, the desire to become a scientist or engineer in poorer countries can also be understood in the light of their lower socio-economic development. Many of these countries are at the same level that Europe was at after World War II. The countries had to be rebuilt. The engineers and scientists were heroes, and this pushed children towards scientific and technical studies. Poorer countries are in a very similar situation today, I guess.

C.S.: The more developed a country is, the less interested the students seem to be in becoming scientists or engineers. These disciplines do not appear as important and meaningful. Rather, they are 'nerdy' and dated. But it is interesting to see that the 'softer' subjects – like biology, medicine, veterinary medicine and environmental studies – do not suffer from this lack of students. For these young people, working with challenges connected to health and the environment is more meaningful than becoming engrossed in physics, maths or technology.

Another paradoxical situation has been observed in regions where S&T are very developed. In the Scandinavian countries

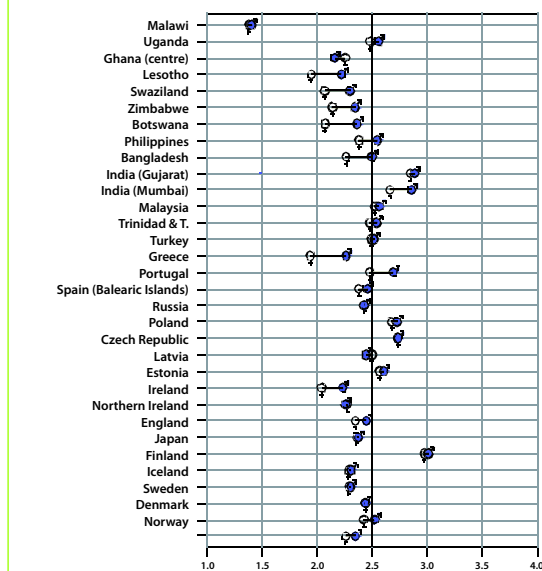
I would like to become a scientist

Source: ROSE Study



I would like to work in technology

Source: ROSE Study



Whether it is a question of science or technology, enthusiasm is clearly stronger in developing and emerging countries than in industrialised states. And, for the technical professions, the differences between girls and boys are more marked. In their responses to these two sentences, the Japanese and the Scandinavians are the least enthusiastic.

and Japan, for example, young people are not only indifferent but even critical and pessimistic about science and technology.

S.S.: Again, we have to be careful with our interpretations. Maybe pessimism is not the right word. Many youngsters in wealthy countries are less concerned about material and economical development. But that does not stop them from being very concerned about the future. Good science teaching could take these views into consideration. Even if the solutions to environmental challenges will not come entirely through science and technology, we have to demonstrate to sceptics that S&T do not just cause problems, but they also offer solutions.

The differences in the attitudes of girls and boys are also more marked in industrialised countries.

Does this surprise you?

C.S.: 'Youth culture' is a modern phenomenon that is widely described in Western societies, but it does not exist in the same way in more traditional countries. This culture is charac-

terised notably by very marked differences in attitude between boys and girls, who all want to express their masculinity or femininity. This differentiation also interferes in their attitudes towards science.

S.S.: Yes, it is paradoxical that wealthy regions, such as Scandinavia, where the level of gender equality is one of the highest in the world and has been a political priority for decades, have a much greater difference in attitude between boys and girls than other countries. These differences are expressed in the value attributed to S&T, but also in many other aspects of their lives.

Youth is the society of tomorrow... Does disinterest in, or lack of knowledge about science and technologies lead to a democratic deficit?

S.S.: Definitely. For me the main problem is not the fact that scientists do not communicate enough with the public. The major challenge for our societies is really that of democratic participation. It is important that the young (and the less young) understand the signi-

ficance of S&T for our culture, our world-view, our way of life, etc. In this way they would have more 'realistic' attitudes regarding the possibilities as well as the limitations of S&T. They should be able to be constructive and critical towards scientists and technologists. They should also develop a kind of intellectual independence that enables them to distinguish between serious science and the pseudo-scientific claims that they encounter through the mass media and in adverts for new products.

Christine Rugemer



www.ils.uio.no/english/rose/



Michel Rocard

Giving science a chance

Innovative experiments on science teaching are blossoming throughout the Union, and are proving benefits for education. The European Commission intends to support their extension and visibility. It has instructed a 'commando squad of educators' – the Rocard Group – to design action lines for such a policy.

Although he is not from the 'hard' sciences, Michel Rocard is a citizen of the Union, and even a Member of its Parliament. Europe's future alarmed him when he learned, almost by accident, that young Europeans are opting less and less for scientific studies. "And particularly in the two important disciplines of mathematics and physics, in which the absolute number of students is decreasing. I expressed my concerns to the Commission, which informed me that a great deal of work had been started on this theme in many Member States, with the active participation of scientists. Janez Potočnik proposed that I head up a small working group, consisting of five well-known individuals in the world of European research who are working in the area of science education⁽¹⁾. Our mission is to draw on these experiences in order to propose European initiatives in favour of a wider balancing of educational approaches."

The *Rocard Group* report was presented in June 2007. It signals a new phase in the field of science education, which the European Commission has been exploring for more than four years⁽²⁾. It has reviewed the gold mine of successful experiments under development in Europe today, some of which have been underway for some time. For Michel Rocard, "it seems to be a given that primary education, at least for those from 4-10 years of age, and

to a large extent in secondary schools, must make a 180° about-face. The deductive approach – beginning with a concept and its consequences, which is then illustrated by means of applications – must give way to the inductive approach, based on first awakening natural curiosity. The success rates of this second method – that is, the number of students who become comfortable with mathematics or physics within a system that may then become deductive – are beyond question".

The *Rocard Group's* educational diagnostics are based on an analysis of various pioneering European experiments, particularly the transnational and interurban *Pollen* project (see page 15) and the German initiative *Sinus-Transfer* (a well-established initiative that trains secondary-level educators in innovative educational approaches).

In what way is the Union useful in this regard?

What can the Union do to defuse the crisis in science education? The *Rocard Group* responds to this question without any ambiguity: begin with these two representative projects – as well as with others – and give them the means to branch out into new areas. The 'Europe effect' is enabling the significant expansion of educational approaches across borders, organising multilingual access and training for the greatest possible number of educators,

and strengthening evaluations. Europe must also concern itself with intelligence – the search for new and innovative educational practices.

At the age of 77, how does Michel Rocard view this upsetting of the traditional canons of education within the context of the current decline? "Science has for a long time been put on a pedestal – the feeling was that science was where the future lay. This idea has changed and the pedestal is now rather lower. Science is everywhere and has become banal. The public is beginning to ask questions about accidents, risks and ethical problems. The scientific authority argument no longer holds – and that's the reality. The problem we are dealing with is how to avoid the disinterest shown by young people in science careers, caused by outdated teaching that obscures what might interest them, and can even alienate them. In this way, on a level playing field with other sectors that attract them, they will at least have had the necessary introduction to enable them to make a choice."

Didier Buysse

(1) Peter Csermely (HU), Harriet Wallberg-Henriksson (SE), Valérie Hemmo (rapporteur, FR), Doris Jorde (NO), Dieter Lenzen (DE).

(2) Science education is one of the issues, since the year 2000, at the heart of the Lisbon Strategy for creating a knowledge economy in Europe. An important step was taken in 2004, when emphasis was placed on the vital need for human resources in research by the Gago Report (named after the physicist, professor and Portuguese Minister of Research, who was one of the Strategy's designers).



Sharing curiosity

"Physics is often taught in schools as if it has been dead for more than a century, a collection of formulas necessary in order to solve exercises. We should present children interested in physics with mysteries, tell them stories about the intriguing properties of matter, about the fields and the universe. Let's show them that physics is a living subject, that more research is indispensable, and in which direction it can go. Inspiration is the key objective."

Rolf Landua
CERN physicist



Jorge Wagensberg

A pendulum that resembles Foucault's Pendulum swings back and forth with the hours. It is surrounded by a circle of rods – knocking one over every ten minutes. It illustrates the relationship between the earth's movement and the passage of time.



This huge tree trunk symbolizes the museum's cultural interaction with the city of Barcelona. Its natural orifices are reminiscent of Gaudi's architecture.

The muses of knowledge

Interactivity and emotion are the building blocks with which Jorge Wagensberg, director of the "La Caixa" Foundation Science Museum in Barcelona, has constructed a world in which the aim is to awaken the pleasure of understanding and finding out more. Here, life is centre stage, with reality the best means to understand it.

Do you have a particular way of raising the general public's interest in science?

Jorge Wagensberg: I start from the fact that emotion is the first stage in scientific questioning. This stimulation, very limited in time and very intense, initiates a dialogue with nature. Indeed any cognitive process starts with a stimulus. That is the way natural selection proceeds. If a species does not feel hunger or the desire to reproduce, it disappears. Knowledge is perhaps the last conquest in the process of natural selection.

Our role is therefore to cultivate this thirst for knowledge. The museum is there to stimulate it and not to quench it. It is not a matter of teaching science but of awakening a certain questioning. By generating emotions and stimulating curiosity we can initiate a dialogue between the visitor and nature. Then comes the understanding stage. I call this the moment of 'intellectual joy'. This again is an emotion that everybody experiences in total solitude. The only real way to learn and be enriched is to arrive at an understanding by virtue of one's own efforts. The museum is there simply to awaken this desire.



© la Caixa

© la Caixa

Visitors can view the tropical greenhouse from the outside, from the inside or from above for a closer look. This approach to nature from different angles is accompanied by interactive effects – such as the simulation of a tropical storm that breaks as visitors arrive.

Many of the exhibition rooms at la Caixa display real objects, unlike other museums where the preference seems to be for the virtual. Do you see the real world as essential to the presentation of science?

I prefer the very worst real objects to the very best copies and I like to describe a museum as a place of 'concentrated reality'. This is because for any object you must associate phenomena. For example, our presentation of rock faces shows the geological strata and deformations caused by seismic activity. These are real sections of rock. One of them shows a fault line that was formed during its geological past. The object – the fault line – is indeed there, but the phenomenon – the formation of the fault line – is not. To present this we therefore had to add museographical elements, such as models or animations. However, these are complementary elements that cannot in any way replace the real world. There is also the matter of respect for the visitor, who should not have to be constantly asking whether what he is looking at is real or not. It is children who taught me the importance of showing the real world. I have always heard them saying "is that real?" That is how I understood that if there is any ambiguity, a lack of trust, then the visitor's whole emotional and intellectual process is disrupted.

This concentration on the real is also fundamental to the work of researchers...

Absolutely. Reality is first observed by the researcher, who is careful not to distort it. It is from this objectivity that science derives its universality. Then there is intellectualisation. This is why you seek points in common between the objects observed but, above

all, also their differences. Objects become comparable to one another. Then, an explanatory model or 'truth' is built based on theory. But this 'truth' enters into dialogue, so to speak, with reality. If it is to be a scientific truth then it must be susceptible to being challenged by reality – it is enough for nature to show one example for which it is not verified. In which case it is not the 'scientific truth' that prevails, but the reality... This is why representation of reality is so essential in a science museum.

Inherent in our approach is an attempt to in a sense expose the visitor to this dialogue that is so essential to the scientific approach and thereby enable him to stand in the shoes of the researcher. Of course, this is very difficult to do in terms of museography. One experiment we tried was to present some of our research and then invite the public to participate. On the basis of the information we provide, visitors can develop their own theory and submit this to us.

How do you measure the success of your initiatives? By the number of visitors?

Quantitative approaches are not the best. Personally, I prefer to observe the visitors themselves. All my new hypotheses came from that. When someone experiences intellectual joy, you can see it on their faces. I hide, I spy and I eavesdrop on what people say as they leave or while viewing the exhibits. Of course now people are beginning to recognise me so it is time I adopted a disguise!

But in today's context of cultural competitiveness, is there not a temptation to opt for the spectacular or to highlight 'trendy' subjects to attract the visitors?

What do you mean by 'trendy'? If the public is concerned about global warming then it is our

job to work on this. A museum is a very good place to present major issues of science and society. We hold regular debates and conferences on such subjects. The museum has the privilege of being neutral ground. Citizens, scientists, journalists, politicians, industrialists... they can all come together at a museum. We can encourage debate between them without taking sides.

What distinction do you make between a science museum and a science centre?

The word museum refers to a place with static objects. A science centre is a museum of phenomena. It is true that the term 'centre' is more suited to my approach. But it is not a term I like. It makes me think of a 'business centre' or 'shopping centre'. Therefore, I use the word museum because it has a certain 'cachet' if you like. Even if it does not reflect the break with traditional institutions. Also, museum has the same root as muse or music.

In seeking to present the scientific approach are you also seeking to acknowledge doubts and mistakes?

Science is not omnipotent and does not control everything. We would like to show that past mistakes can help us avoid future errors and that we can learn from our mistakes as they are a motor for knowledge. Having said that, it isn't easy to show this aspect of science. The explanatory comments alongside certain objects, such as fossils, show that questions remain regarding their identification. We have no hesitation in using the question mark. More abstract concepts, such as uncertainty or order, are presented. Order is presented as an exception and balance as a special case. Uncertainty is presented as underlying quantum physics and biological development. More generally, perhaps this approach makes it possible to illustrate the complex paths taken by science in the face of nature.

François Rebufat



http://obrasocial.lacaixa.es/centros/cosmocaixabcn_es.html/

An exemplary 'school case'

To ask questions, to formulate hypotheses, to experiment is possible at the tender age of six, and even earlier. This is the credo of "La main à la pâte", a teaching initiative sparked by the meeting between a Nobel Prize winner for physics, Georges Charpak, and some very young children. Inspired by an American experiment, the idea took root in France and after a decade is now getting going in an impressive number of countries.

It was a kindergarten class on a June day, in a Parisian suburb," remembers Yves Quéré, physicist and member of the French Academy of Sciences. "The teacher had asked the children to trace each other's shadows in chalk on the courtyard, every hour. Looking at the sort of radiating patterns they had made by the end of the day, the class tried to explain what had happened. A little four-year-old girl shouted, 'Teacher, it turned!' The outburst, however ingenuous, nevertheless clearly showed that the little girl had understood that, somewhere, there had been a rotation."

I don't know...

The study of real objects – no screens, no photographs; interaction between the children; the children themselves handling things. This constitutes the research approach. "Science is based on the phrase 'I don't know', and not the opposite," the physicist explains. This episode reveals all the elements that have made *La main à la pâte* a success. The initiative, which began in 1996, marks the beginning of a crusade by three French academicians to

renew and rehabilitate science teaching. In addition to Yves Quéré, this adventure began with Pierre Léna, astrophysicist, and Georges Charpak, winner of the Nobel Prize for physics (1992). Three researchers dissatisfied with the ever decreasing share of funding that scientific teaching at the primary level received. The trigger for this was a visit to a Chicago ghetto, guided by Leon Ledermann, one of Charpak's American colleagues, where a teaching experiment called *Hands On* was underway. "The school was quite typical of this neighbourhood, with 99% being African-American, most of whom were well below the poverty level, the Nobel laureate remembers. I saw happy children, happy teachers, and an intelligent programme. The kids had an hour of science each day and they took great pleasure in their experiment notebooks, kept since the age of five or six, in which they described what they were doing." When he returned to France, Charpak obtained support from the Minister of Education and from the Academy of Sciences to launch an experimental project involving some 350 schools.

Scientists' guarantee

Ten years later, *La main à la pâte* has become an institution in this country. It has its own Internet site, 10 principles, a charter, an annual prize (awarded by the Academy to the most dynamic schools), literature – books and brochures – conferences and even radio broadcasts, thanks to a partnership with the national information network, *France info*. And above all, it has an impressive capital of teaching experience, appropriately endorsed by that guarantee of scientific excellence, the Academy of Sciences.

It is very interesting that *La main à la pâte*, which began as a resolutely international approach, with the help of American *Insight* documents, in turn awakened a veritable craze abroad. "Many people have made the same observations as we have," remarks Yves Quéré. "Through the IAP⁽¹⁾, where I was co-chairman until last year, the Academies of Sciences from some 15 countries have become very involved with this method, in both the major industrialised countries and in emerging countries, such as China, Brazil and Malaysia, as well as in countries such as Senegal, Morocco, etc."

The promoters of the project are thrilled to see this craze because, for them, it is not only the future of science that is at stake. Educators participating in the project observe, for example, that there is also an improvement in language skills. The children have to formulate questions and hypotheses and be able to understand the answers. "Syntax takes form when there is rigorous reasoning," the researcher points out. In addition, the teamwork and mutual listening that are the heart of the project also teach tolerance and openness.

Yves Sciamia

(1) Inter-Academy Panel, International Assembly of Science Academies



www.lamap.fr/

And soon:

www.mapmonde.org/

Recommended reading

Georges Charpak, Pierre Léna, Yves Quéré, *Les enfants et la science. La main à la pâte, dix ans après*, Odile Jacob, 2005
Yves Quéré, *La Science Institutrice*, éd. Institutrice, Odile Jacob, 2002



The science-gathering bees

Launched in 2006 in 12 EU 'seed cities', the Pollen project is promoting science education in primary schools. By adopting an approach tailored to the local reality, it aims to stimulate pupils, teachers and local actors in a given territory. The demonstrated best practices will then be disseminated.

The Pollen logo shows a nectar-gathering bee, flying from school to school, from town to town. This sums up the project's whole educational philosophy, one of 'pollination of science' by transmitting experimental educational approaches between the various schools and local communities. The shared aim is to give young children a taste for science and awaken their curiosity through an approach based on inquiry and observation. On the basis of simple themes like "Where does bread come from?" or 'The weather and meteorology', Pollen encourages children to think about the world around them by developing their aptitude for problem-solving as well as their command of language and their creativity.

The cities mobilise

The project is being implemented in 12 so-called 'seed cities' that share the desire to get as many people involved in promoting science education as possible. The dynamism of each pilot project is based on a soundly structured plan that creates a bridge between schools, teachers and the local community (families, associations, scientific and industrial partners, municipalities, museums and cultural centres).

In addition to this cooperation, the cities also choose partners of national reputation that possess an expertise and a legitimacy in the scientific field. "In the French town of Saint-Etienne, for example, it is the Mining School, which trains engineers, that regularly sends students to assist the teachers," explains David Jasmin, European coordinator of the Pollen project. "This support is much appreciated by the teachers who generally have no training in the applied sciences."

12 local models

Each town has a distinct social and educative reality for which specific goals have been identified. In the cities of southern Europe, which are often very culturally mixed, parameters such as the family or immigration are an inherent part of the plan. In northern Europe, which is generally more experienced in teaching sciences, the focus is on sometimes more specific approaches, such as the use of Information and Communication Technologies in the classroom in Amsterdam (NL) or an interdisciplinary approach to sciences in Leicester (UK). David Jasmin sees this variable geometry as one of the characteristic features of Pollen: "While bringing a



The 12 Pollen "seed cities"

particular approach to education, one that tends to redefine the role of the teacher, it is also very important to respect the culture and school system of each country."

At the end of the project, each Pollen member city will help draw up a charter of 'science seed cities' that will be widely circulated with the aim of transferring the lessons learned in the project. Over three years, 100 schools, 500 classes and 15 000 children are to be progressively involved. The pollination of science will then be an expanding educational strategy.

Carlotta Franzoni



www.pollen-europa.net

Robots and girls

How do you encourage girls at primary or secondary schools to envisage a future in science and technology?

One European project has hit upon a playful way of winning them over: new-style robots that do not embody martial values and that reassure girls of their abilities.



European schoolgirls account for just 20% of future engineers, electronics specialists and physicists. Why is it that girls show such a lack of interest in scientific or technical subjects? How can we stimulate their interest in these subjects from an early age? For Gerhard Kraetzschmar of the *Fraunhofer Institute for Intelligent Analysis and Information Systems*, coordinator of the European project *Roberta Goes EU*, “the crucial factors in motivating girls are not the technical subjects as such but the way in which they are presented using adapted teaching methods. Our research shows that attending the *Roberta* courses boosts their confidence in their ability to master technical objects and subjects.” Using robots for educational purposes is not an entirely new idea. Designing, building, programming and testing an autonomous mobile device – one that walks and talks in addition to engaging in acrobatics and doing dance steps – helps young people to become familiar with the development of technical systems in their pre-adolescent years, while allowing them to have fun in the process. A one-day programme enables the children to learn basic notions of science, technology, electrical engineering, mechanics, robotics and information technology. “The attractive power of robots and the playful approach removes inhibitions and reduces scepticism,” explain the *Roberta* promoters. “Children are so fascinated that they want to find out more.”

A question of interest

However, neither the usual projects, nor the toys commonly available on the market – often racing cars or battle vehicles – are particularly attractive to girls. The challenge was to identify areas that do arouse their interest. “Girls are more sensitive to environmental problems. We therefore sought models that simulate natural phenomena, like reproducing a colony of bees or ants, for example. We also saw that these fields interest boys too, while the reverse is often not the case.”

The *Roberta* project’s contribution is to develop teaching manuals and software designed especially for science education for girls. It has already proved its worth in Germany, where it has been running for a number of years, with the backing of universities, a science museum, an education council, a grammar school, a women’s advancement centre and the educational division of the Lego company. By expanding in 2007 to include Austria, Italy, Sweden, the United Kingdom and Switzerland, this project, now European, will make it possible to translate the training courses and adapt teaching material to the needs of each of these countries.

A hit with the girls

The attractiveness and quality of the courses are continually assessed by the teachers, and improvements introduced on the basis of their findings. In the autumn of 2006, more than

A fun way of getting to grips with technology that defies the ‘gender laws’.

200 teachers and about 2 600 pupils aged between 10 and 19 (75% of them girls) attended these courses in Germany.

A survey by the University of Bremen with 800 participants (81% girls) found that most of them (94%) found the experience fun, recommended it to their friends (88%), and would like to follow more courses of this kind (72%). The survey found that even a half-day programme stimulates interest in technology, encourages a desire to learn, strengthens self-confidence and gives a playful dimension to the acquisition of knowledge.

It was these results that encouraged partner countries (Austria, Switzerland, Italy, Sweden, United Kingdom) to try out the idea. By the end of 2007, about 12 regional centres should have trained around 100 teachers and more than 1 200 girls and boys.

Cyrus Pâques



www.roberta-home.eu
www.roberta-home.de

The encyclopaedists of the oceans

Travelling exhibition
organised by Mar-Eco
here at the Aquagallery
in Krageroe (Norway)

The unknown abysses of the deep seas are the last great exploration challenge on our living planet, and are the focus of a worldwide scientific initiative known as CoML (Census of Marine Life). Studying the famous mid-Atlantic ridge, the researchers of the Mar-Eco (Mid-Atlantic Ridge Ecosystems) project, who are involved in this programme, have sought from the very beginning to revive the spirit of the great naturalists of the past. They are offering, through the latest media technologies, encyclopaedic film documentaries illustrating their discoveries, which are accessible to all. This 'text book example', in which knowledge sharing goes hand-in-hand with knowledge acquisition, won them the 2006 Descartes Prize for scientific communication.

Run by Norway and bringing together 16 countries (mostly European) from three continents, the *Mar-Eco* project studies animal life along the mid-Atlantic ridge, the famous mountainous underwater frontier from which the Azores and Iceland were formed. After 13 expeditions, the project has collected tens of thousands of specimens and made several discoveries: strange tracks on the ocean bed, formerly unknown species of sponges, cephalopods and fish, as well as new data on the behaviour of animals, from plankton to whales.

Knowledge in real time

The *Mar-Eco* researchers are unique: they are sharing their knowledge in real time. Since the beginning, they have made the popularisation of science part of their research process. By involving journalists, schools, artists and the public at large, and making innovative use of various media techniques, they are offering a literally encyclopaedic introduction to discoveries coming from the wonderfully rich oceans.

"I'm proud to lead a project in which researchers are committed to communication and feel comfortable with it," says Odd Aksel Bergstad from the Institute of Marine Research (IMR- NO), and coordinator of *Mar-Eco*. "Our strategy, which combines science, technology and the fine arts, is a real success. Collaboration with the Norwegian painter Ørnulf Opdahl has, for example, awakened interest in our work among many people who were otherwise indifferent to biology or oceanography." On the *Mar-Eco* Internet site, there are some 40 interesting educational articles. The *back-grounders* (short articles about a topic) provide examples of the scientific dissemination work carried out in all disciplines touched by the project (oceanography, biology, geology, chemistry, physics, technologies). The site also offers virtual scientific cruises by means of the expedition logbook, and some 40 films and innumerable photos. In order to involve schools, the scientists have set up a worldwide network that currently comprises 17 institutions. They have invited teachers and students out

into the 'field', and have connected schools and ships by videoconference. They have led educational projects not only on the exact sciences, but also – and this is one of their ongoing intentions – on technology, human sciences and the visual arts. Having already held some 10 exhibitions, this enormous communications effort has attracted media coverage in 32 countries and 14 languages. The variety, extent and quality of this initiative won *Mar-Eco* the 2006 Descartes Prize for scientific communication awarded by the Union. "To be questioned by the media and the public is a challenge that obliges specialists to look at their scientific contribution within a larger context," concludes Odd Aksel Bergstad. "Some researchers suddenly discovered the astonishing popularity of their disciplines, which is very motivating."

Jean-Pierre Geets



www.mar-eco.no

AND BRIEFLY...



© Latvian Television

Dullais Didzis, scholar and hero of a Latvian TV programme

Science or fiction?

Can a human being mutate into an 'X-man'? Could we unleash a tornado, like the character *Storm*, or emit laser beams, like *Cyclops*? The cult images of the virtual world inspire children to ask questions of this kind. Asking them in these terms can thus be an effective way of getting young people interested in science and stimulating them to learn more. This is the method used by Cinema and Science (CISCI). Its promoters begin with an observation: young peoples' favourite media are film and the Internet. Which box-office hits come to mind? Perhaps films, mostly American, which use special effects in a science-fiction universe? Well then, let's use them to interest young people in science.

The project's multilingual site (EN, DE, IT, CZ, SI, EE, LV) was launched in November 2006. An original educational resource, it offers clips from mass-distribution films and documentaries that illustrate scientific concepts in various disciplines (physics, biology, chemistry, mathematics). Some

examples: could a person's face change after being bitten by another species (genetics via *Spiderman*)? Is the energy of the human body able to drive machines (*The Matrix* – electro-chemistry)? Would it be possible for a comet to cause a mega-tsunami that would destroy the city of New York (*Deep Impact* – astronomy and astrophysics)? But CISCI is not only virtual. In just a few months, a thousand teachers and young people have participated in debates based on films or TV series, organised by the project partners.

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 www.cisci.net/



Malta

Global youth

Created in 1987, Milset, the International Movement for Leisure in Science and Technology, is a non-governmental youth organisation. Subdivided into regional secretariats (by continent), its mission is to be a "member of civil planetary society" and its objective is to develop scientific culture by means of targeted actions with young people, teachers and educators. Various types of meetings (science expos, summer university courses, study trips, training workshops, etc.) are held around the world. This movement has already made it possible for tens of thousands of young people from all backgrounds to meet, share their

experiences and develop projects together. Idealistic, it promotes the values of sustainable development, international cooperation, citizenship, peace and the sharing of knowledge. Its 11th International Science Expo takes place in Durban (South Africa) in July 2007.

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 www.milset.org

The Technopolis magic

Standing in the middle of a soap bubble, stretching out on a bed of nails and feeling no pain, riding a bike on a cable suspended 5 metres in the air... It seems as if everything is possible at the Technopolis centre in Mechelen (BE). Visitors can choose from among 260 interactive and very sensory exhibits, thematic journeys that enable everyone to test their performance (physical, technical, intellectual, etc.), and exhibitions on topics such as health and happiness, all of which are experienced through action (listening to one's heart, riding in a wheelchair, etc.) Seniors are welcome and will become experts in ICT (information and communications technologies) by discovering all the possibilities of a video recorder or a mobile phone. Everyone can ride the *TechnoVelo*, a bike which reacts to thought, accelerating or slowing down as it responds to sensors placed under its user's feet... Astonishing? Yes, and this is the objective of this discovery centre: to welcome families. Technopolis also offers activities aimed at schools with exhibits and activities adapted to various ages.

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 www.technopolis.be



© Technopolis, Centre flamand des sciences

Exemplary Kvarkadabra...

Why do short-sighted people see better when they squint? How does a microwave oven work? What is the twins paradox in relativity theory? The answer to these questions and to hundreds of others can be found in the amazing on-line journal known as *Kvarkadabra*, a jewel of scientific popularisation from Slovenia. Fuelled by around 15 passionate young researchers (biophysicists working side by side with chemists, mathematicians and philosophers), this site offers an animated, high-quality forum, book reviews, a scientific glossary, a look at research news and much more, such as a wide-ranging series of one-on-one conferences. The Slovenian language is no barrier to the dissemination of ideas. Why not be inspired by *Kvarkadabra*, and experience a wonderful example of sharing science?

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 www.kvarkadabra.net



Communication & motivation

"The disciplines of science and technology are often perceived as being difficult, and the results obtained by pupils are frequently used as selection criteria – a worrying phenomenon for both pupils and their parents. Better educational methods are necessary to overcome these obstacles and to convince them of the positive intrinsic value of science and technology, and the jobs associated with this field. However, teachers are often recruited on the basis of their specific competence in certain subjects and not on the basis of their teaching ability."

Frédéric Sgard

Projects Administrator, OECD Global Science Forum

Research, with a passion

Young researchers, qualified scientists, Nobel Prize winners, communicators... What was it that prompted them to pursue a career in science? What does their job mean to them? Some researchers give their points of view.

Alessandro Armando

*Artificial Intelligence
The University of Genoa – IT*

It is difficult to say exactly what drove me to become a researcher... It was a gradual process; a desire to learn and explore and the pleasure of discovery...



Jean Audouze

*Physicist
Researcher at CNRS
FR*

This job gives me the freedom to work when and how I want, and provides me with the pleasure of understanding and discovering the world around us.



Axel Cleeremans

*Cognitive Sciences
Research Director at
FNRS – BE*

The thing that made me decide to go into this profession was a report by Donald Broadbent, one of the great British cognitive psychologists. The feeling of contributing to knowledge, of being able to be creative on a daily basis and of spreading this knowledge brings me immense pleasure.



Christine Chappuis

*Law Lecturer
Geneva University
CH*

I chose to pursue a career in law for the wrong reasons, but I grew attracted to this exciting and thought-provoking field. What I like is explaining abstract and sometimes complicated ideas and demonstrating their specific application to students. This forces you to delve deeper into a subject matter, which helps fuel further research. In turn, this research may prompt a sudden dazzling revelation – even if it is just for a moment, this moment is treasured.



Christelle Chrea

*Nutritional Biologist
Swiss Centre for Affective
Sciences in Geneva – CH*

I never thought of becoming a researcher. My childhood dream was to be a chef and, initially, I trained to become one. I opted for research

because it gave me the opportunity to become involved in a field covering many of my personal interests (the world of smells, the discovery of new cultures), and above all to work with enthusiastic people who passed their enthusiasm on to me. With my job, I am able to think freely and be creative. I also get to meet people from different backgrounds and cultures and tell them about my work. Finally, I think that what I am doing now is more or less my ideal job – working in an experimental and exploratory field on ideas linked to the pleasure of taste and smell.

Martine Collart

Geneticist – Geneva University – CH

When I was little, I always adored all kinds of puzzles and brain teasers. Then at secondary school, I was drawn to the idea of doing research to advance our knowledge of medicine. Later, when I had the chance to work in a laboratory during my biochemistry studies, I immediately knew that this was exactly what I wanted to do. I love everything that has to do with research – such as looking at the evidence, preparing models which may explain observations, setting up and carrying out experiments to prove or invalidate the models. I also love to learn. And the advances in the field of genetics are absolutely fascinating.



Christian de Duve

*Nobel Laureate in
Medicine – BE*

In my second year of medicine, I followed the traditional route taken by all 'good' students of devoting their free time to working as volunteers in a research laboratory. I started in the physiology laboratory. One year later, I had caught the research bug. Since then, I have never looked back.



Anders Karlsson

*Quantum Photonics
Royal Institute
of Technology – SE*

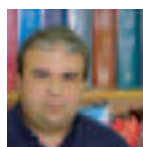
As a child, I built things with Lego blocks and, at school, I always loved physics and maths. At high school, I vividly remember a trip to the Royal Institute of Technology in Stockholm,

where I saw lasers for the first time... As a researcher, you get to stimulate your mind to try and find things out, play around with the latest technology, and meet interesting people from all over the world... what could be better than that?



Marco Kirm
Physicist
Tartu University – EE

I have always been interested in the whys and wherefores. I am driven by the beauty of the learning and research process. And how, after some disappointments, you can finally reach the 'truth' which opens up a new horizon.



Athanasios G. Konstandopoulos
Chemical Engineer
Head of the Aerosol & Particle Technology Lab – EL

I am motivated by the very strong desire to be free to choose and do what I like, instead of being told what to do. But, above all, I want my research to have an impact and be useful to our society.



Guido Kroemer
Molecular Biologist
Research Director INSERM
FR

If you like the smell of mice, the noise of refrigerators, the look of cells under the microscope, nights in the lab and the excitement of bibliographic research, then you have all the right attributes to become a scientist... It is especially during moments when the mind has won a Pyrrhic victory over matter that I enjoy my job as a researcher the most. However, for me the most important thing is to work in a friendly atmosphere where my colleagues are satisfied with their projects.



Klaus Müllen
Chemist
Max-Planck Institute for Polymer Research – DE

Research is to do and learn things that no one has done or learnt before.



Michael North
Chemist – Newcastle University – UK

I have always been fascinated by the unknown, and chemistry offers the unique opportunity to prepare a substance that has never existed before anywhere in the universe and to be the first person to study its properties. I would like to play a part in improving the situation of humanity and be able, through my research, to find chemical alternatives to avoid waste.



Helga Nowotny
Sociologist – AT

Halfway through my secondary school studies, I suddenly discovered the joy of understanding. A problem, which seemed to have nothing to do with me before, transformed part of the world into something that was now mine. This joy has always remained with me. Research is about being curious and never losing sight of what motivates you. It is about testing ideas – be they concepts or empirical findings. And it is about discussing these ideas with interesting people (which does not rule out disagreements), only to start all over again.



Osmo Pekonen
Mathematician
Jyväskylä University
FI

I was attracted to mathematical research at a very young age, having twice participated in the International Maths Olympiad with the Finnish team as a high school student – some might call it a childhood passion. As a scientific journalist, I have had the chance to meet some of the greatest mathematicians of our times. They are often colourful characters who, unfortunately, remain largely unrecognised by the public. I don't think I will ever leave the beautiful world of mathematics.



Wendy Sadler
Physicist
Science made simple Cardiff
UK

I chose to pursue a career in science communication because I love the expression on the faces of an audience when people understand some element of science for the first time. I am passionate about physics and I like the opportunity to share that passion with as many people as possible. Physics has always been a way to help me understand the world – from the colour of the sky to the way my TV remote control works. Students have such a negative stereotype of physicists that I like to see if I can make them change their opinion and even get them excited by it.

Javier Tejada
Physicist – Barcelona University – ES

When I was a child, I liked watching my father, a chemist, work. What motivates me? The search for new ideas and carrying out new experiments. Hearing nature's response and playing a game of questions and answers in science are the most exciting things for me.



Lise Thiry
Virologist
Free University of Brussels – BE

I had a long-held ambition to be a researcher... Although I loved general medicine, I started working at the Pasteur Institute because of my baby, in order to have fixed working hours! But then I was bitten by the research bug. What has research taught me the most? That curiosity is not a bad thing. It should also be nurtured in everyday life

● **Alexandre Wajnberg**



A chemistry whiz

Could he be called “The Mozart of chemistry”? Winner of the European Union Contest for Young Scientists in 2006, Tomasz Wdowik is blessed with both ideas and perseverance. He has been interested in chemistry since the age of 12, proving that science still exercises its fascination over some of the younger generation. Since leaving high school, he has been working on the organic synthesis of a new beta-blocker, the family of molecules used to treat cardio-vascular conditions. We take a brief look at an unusual journey.

Tomasz Wdowik
at his stand, at the
EU's Young
Scientists Contest –
Stockholm, 2006

Tomasz Wdowik has always been interested in science. As a child, it was physics, astronomy and biology that attracted him – until he went to Rzeszów secondary school (Poland) when he was 12 and discovered chemistry. “I was fascinated by the changes in colour... And then I got hold of a book about organic chemistry and was totally hooked.” His teacher, Genowefa Napiórkowska, told some research scientist friends about his curiosity and enthusiasm, with the result that, at the age of 14, Tomasz was given an opportunity to work in one of the labs in the local engineering school under the eye of Grażyna Groszek and to undertake the synthesis of an organic molecule. “I loved it. I would work all during the holidays, sometimes on Sundays... I much prefer chemistry to football, which is just not my cup of tea... That said, I also like classical music and musicology.”

The surprises in Stockholm

At the end of his final year in secondary school, Tomasz Wdowik was chosen by the Polish selection board to take part in the 18th European Union Contest for Young Scientists in Stockholm, in September 2006. “My research was not undertaken for that purpose. It was already well under way. It has to do with the complex organic synthesis of a new compound in the family of beta-blockers, molecules that are used in the treatment of diseases and conditions of the cardio-vascular system, such as cardiac arrhythmia, hypertension, migraines, and glaucoma.”

The challenge was enormous. In the months before the competition one of the seven stages of the synthesis ‘didn’t work’, bringing the process to a standstill. By altering the conditions of the reaction, trying first one thing and then another, and by searching, Tomasz Wdowik came up with an answer.

September thus found him in front of the panel of judges, explaining what he had done in somewhat hesitant English. “Besides the steps of the chemical synthesis itself, the posters on my stand described the biochemical principles of the action of known beta-blockers. That was necessary for an understanding of the structure of this new molecule and the reason for trying to create it. I could see that the judges were interested, but I didn’t expect first prize.” This recognition gave him new wings. During those days in Stockholm he got to know some of the other competitors, took an interest in their projects and met research scientists from every field. On his return to Poland, Tomasz entered the Warsaw University of Technology.

Molecule by molecule

As well as being a student, Tomasz is also – at the age of 19 – a member of a research group at the Institute of Organic Chemistry of the Polish Academy of Sciences. The group, headed by Jerzy Wicha, works on methods of synthesis of natural products. Its goal is “to achieve something new in chemistry, discover new ways to synthesise certain molecules... Synthesising organic compounds is very difficult. One of the hot spots in this field today is total synthesis – that is, the possibility of building up very complex molecules from very simple ones. Finding the right path is almost an art. I have started on the total synthesis of a natural molecule isolated from a sea sponge. I am still at the trial stage, testing different routes. Everything is still wide open.” What about the molecule from the competition? “That’s over now. Research scientists from the pharmaceutical industry are investigating its action. When they are finished we will know whether or not that molecule, which has been registered with the Polish Patent Office, is a good beta-blocker.”

Alexandre Wajnberg



Young Scientists European Contest
<http://ec.europa.eu/research/youngscientists/code/bergen.htm>
Jerzy Wicha's group
www.icho.edu.pl/ENG/groups/18/18.htm

Bukavu calling Geneva. Congolese children put their questions directly to Swiss children on the basis of the subjects proposed by the project. But only after finding the right time-slot, obtaining a good telephone line and taking the plunge to communicate...



Swiss education

The Swiss don't do things by halves, and confronting young people with the true interdisciplinary nature of science is something they take very seriously. Initiatives by Geneva University are opening the door to new, multidisciplinary educational methods applied to environmental issues.

In 2003, a project entitled *Antarctica* enabled Swiss pupils to immerse themselves in an original way in the study of the polar regions and their associated astronomical, physical and biological phenomena. The project was the brainchild of the *Passerelle* team from Geneva University. Designed for primary school pupils, the adventure culminated in a secondary school pupil, an astrophysicist and a journalist being invited on a trip on board an ice-breaker to observe the total eclipse of the sun in Antarctica. Meanwhile, back on dry land, the children were put into telephone contact with the seafarers, asking them questions about life on board the vessel and what they could see. "All of this lent a human dimension to what they were learning about and was really a magical moment that at the same time gave real meaning to the classroom activities," explains Sophie Hulo, a biologist and member of the *Passerelle* team.

The second project, *climaTIC-suisse*, is set to run for two years and involves 40 primary school classes and a group of 15-year-old secondary school pupils. By focusing on the issue of environmental change, it aims to build bridges between the natural sciences and the humanities.

For the very youngest, a comic book and special thematic dossiers have been developed as aids

to discovering and understanding the world around them. The children were able to test them in concrete situations, by participating in interactive surveys on the subject of wood and forests that gave them the opportunity to put their questions to the experts as well as to members of the general public.

Intercontinental exchanges

The highlight last March was when the young pupils were able to deepen their knowledge by means of a survey carried out in the Democratic Republic of the Congo (DRC). They remotely guided two investigators in the field as they bore witness to a complex reality that includes the problem of deforestation as well as that of child soldiers.

During the expedition to Bukavu, photographs and a travel diary were placed on the project's website every day. "This educational experience is a textbook case of how to immerse oneself in another reality, to improve understanding of the links between North and South, between the local and the global, and between the natural sciences, humanities, and social sciences⁽¹⁾."

Secondary schools have been active too. Since September 2006, five secondary school teachers in Geneva have been teaching a multidisciplinary course based on environmental themes suggested by their Congolese colleagues and

that relate to their reality: mines, water, waste, biodiversity, climate change, and deforestation. These five Swiss teachers – of history, geography, physics, economics, law and biology – learned to work together over a 12-month period as they developed this optional course chosen by 11 pupils. They also developed their own cross-disciplinary teaching method on the basis of the substantial documentation provided by the African partners and the *Passerelle* team.

After a few months devoted to the theory, the secondary school pupils embarked on phase two of the project. On the basis of real situations in the east of the DRC, such as a landslide near Bukavu in the Great Lakes region (Kivu), they are going to try and come up with a 'solution' by drawing on the knowledge and tools acquired during the first phase. These proposals will subsequently be assessed in the light of local constraints by Congolese university students. "The aim is to make young people aware of the need for a systemic approach – that is, ecological, human and social – to these issues. This enables them to adopt an investigative and research-oriented logic, one that is genuinely scientific."

This approach is being facilitated by an impressive volume of documents, a database, links with other websites or blogs, and the discussion forum on the *climaTIC-suisse* website. "We are working with just one class and just a few pupils, which may seem disproportionate. But the material developed is available online and is accessible to all teachers as well as to the general public." ●

Didier Buysse

(1) All quotations are by Sophie Hulo.



www.climatic-suisse.ch

Teachers aided by computers

Launched in June 2005 by the European network of departments of education, European Schoolnet, the Xplora portal provides a vast online media library for scientific education. Soon, without doubt, it will be impossible to do without information and communication technologies (ICT) to stimulate interest in science in classrooms. We shine the spotlight on a new type of teaching.

According to many science teachers in Europe, *Xplora* is like a breath of fresh air. "The best experience of my career," states Lidia Minza, a chemistry teacher at Vasile Alecsandriă Galati school in Romania. "Science teachers must always have access to new practical resources which are effective and attractive to their pupils. In this respect, information and communication technologies have incredible prospects in the teaching of science."

By providing free access to teachers, students and scientists, the *Xplora* portal uses the snowball effect. "First you have to motivate teachers if you want to motivate students," explains Karl Sarnow, the project manager, educational coordinator and teacher of maths, physics and IT in Hanover (DE). "If you want to increase the number of science students, you have to concentrate directly on European schools."

Classrooms and open sources

To encourage teachers to introduce new IT and multimedia tools into their lessons, the *Xplora* designers had to find an ingenious way of reducing to a minimum the technical and financial obstacles associated with the installation of the software. Therefore, they initially recruited a group of teachers involved in ICT and educational innovation in order to find the best means of assisting teachers and spreading interest in the project.

Supported by the learning platform Moodle⁽¹⁾, the team created the Knoppix DVD, which has the educational resources of some *open source* software that can be copied and passed freely between teachers and students. The teachers can add their own resources or additional information to provide more depth on a particular subject. In order to optimise these electronic lessons, *Xplora* has just created the *Mouse* concept (*Moodle On USB Stick Environment*) which enables whole lessons to be stored using a simple USB key.

The interest of these educational resources lies not only in facilitating the teacher's research work but, above all, in stimulating the pupils' interest, allowing them to work at home on their Knoppix DVD or their *Mouse*. According to Karl Sarnow, the use of *Mouse* has provoked real enthusiasm amongst science teachers. "It allows maximum manoeuvrability

of the content and they can also add their own touch."

As with all widespread projects on a Community scale, *Xplora* is faced with the multiplicity of languages. The resources are currently available in English, French and German. Additional versions depend on the involvement and motivation of teachers who may voluntarily offer translations. "The level of participation in *Xplora* is essential," stresses Karl Sarnow. "This has to be a real online community where teachers are not only users but are also proactive."

The genius of the webcam

The educational interest of *Xplora* lies not only in the techniques it uses but in its content. As a self-respecting scientist, Karl Sarnow insists on observation in science lessons. "A lesson without practicals and observation is a wasted lesson." Observation can be virtual. *Xplora* therefore provides remote-controlled scientific experiments via the Internet, which are proving to be very successful in secondary schools. The 'real' experimental equipment is installed in a university or science museum and directly connected to the classrooms via a webcam. Pupils from different schools and different countries can then observe and participate together in experiments which are too complicated or even too dangerous to be performed in the classroom.

Eleni Kyriaki, a science and IT teacher at European School II in Brussels, thinks these new methods make science teaching more exciting. "They allow pupils to observe a real experiment and arouse their interest. However, you have to remain vigilant and not leave pupils too much to their own devices on their computers. It is necessary to guide them and clearly show them the procedures to follow to obtain a result."





Karl Sarnow thinks these experiments demonstrate how an informal and enjoyable activity can be integrated effectively into a school environment. After two years, *Xplora* has made its mark and is appreciated by numerous teachers. Its actual impact on pupils remains to be seen.



www.xplora.org
<http://www.europeanschoolnet.org/ww/en/pub/eun/index.htm>
www.xplora.org/ww/en/pub/xplora/

Carlotta Franzoni

(1) Moodle is an online learning platform under open source licence used to create learning communities around educational subjects and activities.

Two examples taken from *Xplora*

Four seasons, the stars and customs

An examination of science, religion and history using the same experiment is far from being absurd... By recording the exact time and the precise place of the sunset using specific astronomical dates, groups of pupils will discover the link that exists between the stars and the calendar of a particular civilisation. They will then be able to answer various questions like: "What are an equinox and a solstice?" and "Why are Easter and Christmas celebrated at these times of the year?" Using discussion forums and pictures, schools will be able to compare and share the results obtained and their different traditions. Teachers and students particularly appreciate this multidisciplinary approach which brings together subjects such as astronomy, geography and religion, and also draws them into one experimental workshop.

Millikan and the elementary charge

Robert Andrew Millikan's oil drop experiment, together with other work, won him the Nobel Prize for physics in 1923. How did it work? All you have to do is put an electric charge on oil droplets and try and measure the electric charges obtained. To do this, they are atomised successively between two electrodes whose potential is varied until they are immobilised, thereby balancing all the forces acting on them, including their own charge. Then, the electric potential of the electrodes is measured and the charge of the droplets is deduced from this. Due to the variability of the droplet mass during atomisation and the variability of the electric charge process itself (by friction or by ionisation), different electric charges are obtained almost every time. Millikan observed that they were all multiples of the same value, e , i.e. the elementary charge of the electron. Its actual value is $1.60217646210 \times 10^{-19}$ coulombs (C), whereas the value obtained by Millikan was 1.592×10^{-19} , due to a probable inaccuracy in the value for the viscosity of air. Too complicated to be performed in class, this experiment requires a considerable number of values to be significant. *Xplora* has therefore just launched a new web concept enabling the results from various schools to be pooled into a database available to everyone. Once these values have been collected, students will be able to compare the charge values obtained and note, like Millikan, that the results are not continuous but discrete, and that the values are all multiples of e . It represents an excellent initiation into collaborative research.

Pencil analyses

Pencil (Permanent European Resource Centre for Informal Learning) is part of *Nucleus*, a group of projects supported by the Union using the Science and Society action plan of the Sixth Framework Programme. Its objective is to identify how informal education, practised in particular in science museums and centres, represents a source of knowledge capable of supporting and supplementing school education. In other words, how 'the informal' and 'the formal' can be brought together. This is not surprising as the project is coordinated by the *Ecsite* network (European Network of Science Centres and Museums).

At the heart of the initiative, 14 science museums and centres are launching different networks and projects to analyse a way of bringing these 'cross approaches' into new educational practices. These small-scale networks – a matter of efficiency – are characterised by the diversity of their participants (schools, pupils, educational associations, researchers, national directors of education, specialists in science communication). At the same time, members of an academic think tank (two universities) will present the best examples of various practices in scientific education based on 14 pilot projects.

The *Xplora.org* site already represents an important tool in this new strategy.



www.ecsite.net

AND BRIEFLY...



Fascination of Light, an exhibition travelling across Europe

Ecsite

In 1989, twenty-three managers of science centres and museums gathered in Heureka (FI) and decided to work as a network. This initiative, which has been given the name *Ecsite*, now has 385 partners – including zoos and aquariums, universities and research centres. Its membership is not insignificant, with more than 30 million visitors each year (of which over 60% are under 25 years of age) and many more via the internet.

Ecsite's objective is to encourage links between these various European centres of education which share the same desire to spread scientific knowledge amongst the general public. Their common objective is to provide knowledge in an attractive and comprehensible way, often by encouraging debate on the problems of the science/society relationship. The network facilitates meetings, ideas, the exchange of good practice and common initiatives. Many European projects presented in this issue are coordinated or placed in a network by *Ecsite*, such as *Pencil*, *Hands-On & Brains-On*,

Decide, *Wonders*, *Connect* and *Nanodialogue*.

 www.ecsite.net

The benefits of interaction

A combination of formal and informal education, school lessons and interaction with science centres: this is the philosophy of the *Hands-On & Brains-On* project, which brings together eight European science centres and museums. The European *SchoolNet* and *Ecsite* networks are responsible for linking these organisations with teachers and a number of projects have been started. For example, the coordinator of the Finnish centre, Heureka, heads a chemistry group whose project, *Colourful Chemistry*, has been presented to and tested with its partners. The ultimate objective is to establish best practice, combining complementary methods – in classrooms and elsewhere – with providing an initiation into the sciences.

 www.ecsite.net/new/blank.asp?type=projects&keyword=Handson

www.heureka.fi/portal/englanti/about_heureka/research/hands_on_brains_on_project

Colourful Chemistry project presented at Heureka (FI)



Péter Csermely

Mentoring in the Hungarian style

In order to encourage the careers of budding scientists, there is nothing like the method of recognising their ability to conduct their own research. This is what made the Hungarian initiative *Kutató Diákok* such a success. It was created in 1995 by Péter Csermely, a molecular biologist at the *Semmelweis* University in Budapest, whose passion for science communication won him the Descartes Prize in this field in 2005.

Each year, a thousand youngsters aged between 14 and 20 are brought together for summer training courses, where they act as trainee researchers in the areas of their choice. Within a decade, registrations have increased tenfold. The best will have the chance to participate in other research programmes, in Germany, Israel, Ireland or the USA.

 www.kutadiak.hu/uj/56-4746.php

The super heroes of Cybernia

The Resistors form a group of four super heroes. They are fighting to save their planet, Cybernia, from invaders. Each of them is an expert in his technical field.

Luc knows everything about optics, Sonia about sound, Amber about electricity and magnetism, and Dig about ICT and nanotechnology. Using familiar play station formats, their site offers games, animations and other interactive tools popular with adolescents. All this allows complex high-tech concepts to be explained in cyber language. Equality amongst the genders is respected and the beautiful heroines should boost girls' interest in science.

 www.theresistors.com/

The old lady in the subject

1901. This was the occasion when four teachers from Eton College (UK) held a conference to shake up their public school colleagues. In their eyes, it was high time that the way in which the natural sciences were taught was changed. The move was made. Groups, debates and ideas were pursued until the Science Masters' Association and the Association of Women Science Teachers were brought together in 1963 to form the famous Association for Science Education (ASE). Combative, imaginative, closely examining all educational methods and possible educational reforms, the ASE now brings together 15 000 teachers (from all levels of education) and 2 500 students. Its strength is demonstrated by its annual conference, which attracts 3 500 people and a reputation that extends far beyond the borders of the United Kingdom.

 www.ase.org.uk/



The link between science and society

"Should public opinion be intrinsically a problem that can only be dealt with retrospectively, after an issue has arisen? Should society not wait until after the science has been completed before getting involved? This reasoning is nonsense, particularly as public involvement is already a reality – whether we like it or not, whether we encourage it or not. Research policy in a democratic Europe must take public opinion into account, and it should do this from the very start.

Today, the question is not so much as to whether the knowledge society is compatible with democracy. It cannot exist without a society that is truly democratic in all its processes, including the governance of knowledge."

Massimiliano Bucchi

*Sociologist of Science,
Trente University, Italy*

A classic moving with the times

Victorian in style and vast in size, the Natural History Museum in London could make some people want to give it a miss. That would be a mistake... At the entrance, under a grandiose vaulted ceiling, children skip around a diplodocus reminding you that here you can touch, explore and find out more in a relaxed atmosphere that takes nothing away from the quality of the knowledge on show. There are also 300 researchers working at the museum, and the botanical, entomology, mineralogy, palaeontology and zoology collections contain more than 70 million objects.



Child with a magnifying glass

London, like many European cities, harbours a true museum. A natural history museum which dates from the 19th century, and which houses collections, accommodates researchers and is responsible for managing a wealth of items and knowledge. However, like a number of museums, this London museum – particularly with the dynamic effect of the science centres – has had a rethink about the way its treasures are presented to various sections of the public (schools, families, people interested in the debate about science and society, etc.).

Presentation and simulation

Apart from the mineral gallery – a Victorian-style display with an outmoded charm – the various rooms benefit from a carefully designed style of presentation. This is demonstrated by the collection of dinosaur fossils in the 'Blue zone'. In addition to the sight of these animals which have been extinct for millions of years, impressive in itself, a set of walkways allows visitors to walk amongst the bones and examine

at close hand how these giant reptiles have been reconstructed. The star of the show is the tyrannosaurus, an enormous life-size robot which roars and moves, fascinating young and old alike. A gadget? Absolutely not. "There is no reason why learning should be boring," comments Sarah Hone, a member of the museum's educational team. "We need to play, otherwise we don't remember anything," confirms a child whilst another delightedly announces, "because here you can touch everything."

Anyone wanting more information on the subject can access the museum website once they get home, to answer the question: "What dinosaur are you?" and can then go on to find out much more about it. In the 'Kids only' area, they can play interactive games suited to their age group and gain access to educational links (particularly to BBC sites) concerning these questions.

A bit further on, the 'Red zone' is devoted to Earth geophysics. The walls of the immense Earth Hall are painted with representations of

the solar system and the constellations. An enormous sphere representing the Earth is suspended in the air and pierced by the escalator leading straight to the vulcanology exhibition hall. The air of mystery surrounding everything makes you want to find out more. How, for example, does a volcano suddenly spring into action? A model explains how a magma chamber works. What does an earthquake feel like? Visitors can 'relive' the Kobe earthquake (1995) as the ground movement recorded during this earthquake is reproduced.

Researchers with no secrets

Besides what it offers the general public, the museum is developing a policy aimed at schools, supported by an educational team that helps take care of the children from the moment they arrive. Teachers have a choice of various educational activities offered in a virtual catalogue. Puppet shows enable the smallest of children to become acquainted with natural history. Actors lead the children into investigations through the various galleries of the museum. The character of Circadian Sam, for example, who never knows if it is day or night, but has a very good knowledge of all the animals, asks the children to help him find



A cathedral hall... full of noise and life.

out which ones are asleep and which are awake. Mary Anning, a 19th century fossil hunter, tells them about her life and leads them to discover several scientific theories. The schoolchildren can also metamorphose into 'dinosaur scientists'. Equipped with a laboratory coat and a notebook, they explore the museum to find out about the feeding habits, movements and habitats of these extinct giants.

For older children (12 to 14 years of age), an Earth Sciences programme offers various types of activities. They can, for example, use a microscope to examine minerals and identify their formation cycle. If they have happened to find their own specimens while out on a walk, they can try to identify them using the museum collection database, through a set of questions and answers.

The more elaborate "How science works at the museum" exhibition offers students the chance to become researchers, by conducting experiments to solve problems and then discussing industrial applications for the techniques used. An example of this is determining the geological age of a piece of clay using palaeontological techniques. The objective is to become familiar with the

methodologies, in order to be able to put forward hypotheses and verify their soundness. As for the museum scientists, they are not confined to their laboratories. Their work is varied – from the study of ecosystems and environmental pollution to the propagation of diseases transmitted by insects, such as malaria – and they do not hesitate to enter the arena to explain their procedures and deal with the children's questions. For example, a palaeontologist will tell you how the analysis of a fossil's teeth reveals what this creature ate during its life on Earth, and an entomologist will reveal how insects can help solve a crime. By contrast, a visit by the public to the Investigate Centre provides more information on the secrets of meteorites, snake skins and all sorts of bone. All these objects that the researchers are working on can be touched, handled and examined under the microscope and electronically identified. This gives young children a foretaste of this profession.

Stéphane Fay



www.nhm.ac.uk/

Lesson:
a researcher
presents
a fossil.





Luigi Amodio: "Even if they are not experts, citizens must have their say and be free to decide what they want and don't want in their everyday lives."

A homage to the informal

*Director of the Città della Scienza ('City of Science') in Naples and a professor in the Faculty of Sociology at the University of Naples Federico II, Luigi Amodio is a firm believer in a culture of interaction. It is an approach he supports through many educational initiatives at the Città, as well as citizens' debates, such as the European Nanodialogue project that he initiated. research*eu spoke recently with Luigi.*

As a centre for sciences, the Città complements 'conventional' science education. What are the benefits of an institution such as yours?

Science centres are an informal place where everyone feels free to express themselves and to make mistakes. They are places where everyone can come into contact not only with different types of people, but above all with different types of objects and scientific exhibits. They are interactive and fun places, and this makes them different from more formal places of learning, such as schools or universities. However, education in schools, and also the teaching resources provided by the media, are just as important. Each approach has its own particular context and provides a different kind of knowledge. An ideal learning path should provide the scope to benefit from them all.

For a child, for example, the first visit to a science museum with a parent is a learning experience that can be very lively and a lot of fun. The child will not have the same kind of experience at school with his teacher, who transmits knowledge of a different kind.

Let us turn to the Nanodialogue European pilot project that you initiated. This project has just ended. What do you think it achieved?

The *Nanodialogue* project was based on themes such as ethics and the impact of nano-technologies on society. We therefore sought to expose both the positive and potential negative aspects of applications in this field. Even if they are not experts on the subject, citizens must have their say and be free to decide what they want and don't want in their everyday lives.

Such debates are very effective, not so much in convincing, but in providing food for thought. It is a question of knowing whether or not we are ready to embrace these new technologies. The first important lesson we can learn is that the general public does not fear the progress of these innovations. But knowledge does not necessarily mean acceptance. The final evaluation showed that a large majority of those who participated in the project may not necessarily be in favour of nanotechnologies, but they are in favour of research. That is in itself very positive.

What was your strategy for getting young people interested in the exhibition that underpinned the debates?

It is true that adolescents generally lack basic knowledge about 'contemporary' science. So we had to find a way of explaining things to them that was simple, yet original. Sketching scenarios of the future is a very effective way of communicating with young people. Therefore, we tackled the subject of ethics by applying the science fiction model, a genre with which many young people are familiar. We also tried to explain how problems relating to nano-materials can arise. Using such everyday items as cosmetic creams and rechargeable batteries, we clearly set out the difference between a 'normal' product and a 'nano' product. It was quite fascinating to see how young people – and the not so young too – reacted and interacted as they visited the exhibition, despite the fact that the concepts are far from simple.

You are also closely involved in the popular dimension of the 'science and society' debate. To what extent are young people engaged in this debate?

Young people have their own value system and that is why a question will not be put to them in the same way as it would be put to adults, nor will the answer be identical. Yet, it remains essential to involve children and young people in any kind of scientific debate, as they are the citizens of the future. In this respect, cultural institutions and science centres have a fundamental role to play as they 'accompany' young people and teach them how to develop a critical mind.

Carlotta Franzoni



www.cittadellascienza.it/
www.nanodialogue.org

A breeding ground for a high-tech future

Interactive exhibition



© la Città

Built in the 1980s on a brownfield site at Bagnoli (Naples, Italy), the Città della Scienza is a vast crossroads of interactive and virtual knowledge. Its distinctive feature: a desire to integrate different players and resources in the same region into a shared development model. A report on a 'city' that is looking to the future.

View of the entire Città, a multi-purpose and busy science centre located in a harbour-side industrial landscape.

The Città della Scienza is more than a science centre. Its managers want to involve those who come to discover advances in research and technology. They want to make them aware of the key role played by the public in this development and in the choices they have to make in these areas. They also propose to bring together various players (researchers, teachers, managers and the public) to work towards the same ambition: to revitalise the regional economy using several sources of development.

Covering 12 000 square metres of a former industrial area overlooking the bay, this showcase of Neapolitan innovation is made up of three parts: a 'living science museum' for education, a business technological innovation centre included in the European network of Business Innovation Centres (BIC), and an advanced multimedia training centre.

Captivating the youngest ...

Thanks to an educational section, pupils can immerse themselves in science subjects in a variety of ways (mathematics, physics,

chemistry, astronomy, geology, life sciences), but also in other fields, such as music. They take part in interactive exhibitions and in different workshops. Whether from nursery school or secondary school, the groups interact through a wide range of activities which reveal both the magic of science and its everyday consequences. The act of 'participating' is of fundamental importance here. "With the growing presence of multimedia and the internet in our society, it is easy to fall into a certain passivity," explains Luigi Amodio, director of the Città della Scienza. "It is very important for children to have an active role in their scientific education."

The 'Theatre of Sounds', for example, allows young children to improvise with sounds and music without using notes or notation. As for adolescents, they can try out more specialised experiments to give them a better understanding of innovative research. For example, a virtual molecular biology experiment teaches them to determine a specific DNA sequence in a bioinformatic database, and to use multimedia software to simulate the most commonly used research techniques.

The wide variety of activities at the Città demonstrates that science is everywhere... even in pizzas. Here in Naples, where the pizza was created, children can observe the life-cycle of its ingredients: flour, olive oil, mozzarella, tomatoes.

...to give them better guidance

Concerned about providing southern Italy with creative talents and innovative technicians, the multimedia centre provides information and training that ranges from simple advice to an introduction to IT and software. Finally, in this dynamic Città, the Business Innovation Centre acts as a catalyst for the future.

Accommodating innovative businesses, this area covering 4 000 square metres provides them with advice and services: start-up assistance, finance, market research and marketing in the region, sustainable development, aid from the European Commission, etc. One of the BIC's strong points is its 'incubator', which houses companies mainly involved in the information and communication technology sector, providing them with the innovative technological infrastructures they will need to grow. In recognition of its innovative development model based on the region's resources and the need for social change, the Città was recently awarded the 2006 Descartes Prize for Communication.

●
Carlotta Franzoni



www.cittadellascienza.it



Gerard 't Hooft
(foreground) and
Robbert Dijkgraaf

High flying table talk...

The idea of a science café in the Dutch town of Nijmegen is definitely a winner. Eminent figures and even Nobel laureates are happy to come here and talk about their subjects. The public appreciates the cheerful informality of these events. On an otherwise normal March evening, the place is packed despite the somewhat abstruse topic: string theory!

Tonight we have an absolute record turnout!" Françoise Touahri is exultant. She has been living in Holland for a number of years now, and the idea of a science café was something she borrowed from her native Montpellier. In 2004, there was nothing of the sort in Nijmegen, and the friends and colleagues she mentioned it to were promptly sold on the concept. The private sector (Philips, where she was working at the time) supplied the initial financing. "Right from the first event, in February 2005, it was a success." Since then, several times a year, a hundred or so people have packed themselves into a café in the centre of the city where, beer in hand, they listen to and engage in a discussion with men and women from the realm of science. Before and after the presentations and debate, a live orchestra plays in the smoky atmosphere. No platform, no stage set. The scientists sit on bar stools, in front of a white cloth. When all the tables are full, people sit on the floor, or pull a folding stool out of their backpacks, or remain standing. "To get things going, we ask our guests to make a short presentation, giving their point of view," Françoise Touahri explains. "We usually invite several scientists, so people come to realise that different approaches are possible."

On this particular evening, the guests are extremely eminent indeed: Gerard 't Hooft⁽¹⁾, a Nobel Laureate in physics in 1999 and a

professor of theoretical physics at the University of Utrecht's Spinoza Institute (NL), and Robbert Dijkgraaf, a professor of physics at the University of Amsterdam (NL). They are delighted with their largely student audience, and it shows. "We are especially glad to see them, because in our field most new ideas come from the minds of younger scientists," says Gerard 't Hooft. "This informal type of discussion is particularly well suited to theoretical physicists. We don't need any complicated equipment," adds Robbert Dijkgraaf, who remembers long debates on a Mediterranean beach with his professor (Gerard 't Hooft himself) during a symposium.

Popularise, it's good for you!

Here it's more about passion than knowledge. "All the scientists we ask are happy to accept our invitation. Even famous people who are much in demand come to us. Obviously, we are delighted," says Françoise Touahri. "Right from the beginning, you can tell that they are talking less about their work than about their love for their science and the subject of their research."

Gerard 't Hooft adds that what he likes in this dialogue with a general audience, as in teaching, is that it forces you to step back: "It's good for you. Explaining physics concepts and theories to someone who knows nothing about it, forces you to talk about the whole forest and not just one or two particular trees. That opens

everything up to question and makes you think, step by step, about the intellectual edifice and how it was built up."

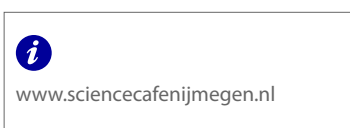
The audience, listening attentively to the two speakers, is carried away by ideas of strings, membranes, 10- or 11-dimensional space and other highly abstract subjects. A mixture of the young and not-so-young – apparently from related disciplines – and a handful of man-in-the-street types. Everyone seems very happy. This is confirmed when the floor is opened to questions, some of them (apparently) naïve, some very much to the point. String theory is put to the debate, and not only in the scientific sphere...

If you could take away just one thing from an evening like this, what would it be? "For me, it would be that physics is full of big questions, to which we know only a fraction of the answers," is Robbert Dijkgraaf's response. To which Gerard 't Hooft adds that "to immerse yourself in physics is to let yourself be touched by a sense of the extraordinary."

A couple of hours spent in this atmosphere was certainly enough to convince me!

Kirstine de Caritat

(1) See the 'portrait' in RTD info n°35.





Making science colourful

Very few young people from ethnic minorities – a significant group in Europe – enter science and technology. The reasons are not hard to understand. But what can be done to change this situation, and to ensure equal opportunities? The European ETHNIC project suggests that this road must start in schools.

In 2006, children of Afro-Caribbean and Asian origin accounted for 21% of the primary school children in the UK, and 17% of secondary school children. Other minorities (principally from Turkey and the Maghreb) are represented in similar proportions in other European countries. They constitute a potential reservoir of human resources that for socio-cultural reasons is all too often excluded from the best schools and higher education. In 2003, the *Ethnic* project was set up to encourage these children to take an interest in science and technology, to stimulate greater awareness among their parents and teachers, and in general to awaken the scientific community and the media to the problem. Operating in six countries, the *Ethnic* partners have targeted different population groups: Afro-Caribbean children in the UK, Turkish children in Austria, Filipinos and Peruvians in Italy, and the sizeable Roma populations in Hungary, Slovenia and the Czech Republic.

Fighting stereotypes

"The principal obstacle to the participation of ethnic minorities is the existence of stereotypes that reinforce the perception equating 'scientist' with middle-class white man," explains Elizabeth Rasekoala, director of the African-Caribbean Network for Science & Technology, a British network closely involved with the project. "The language of school books, museums and the media does nothing to highlight the truly universal nature of science. Because of this insidious image, which is also found in the classroom, children from ethnic minorities (and the same is true of girls) simply do not see themselves as future scientists or engineers. In general they suffer from a lack of access to science culture, and from low expectations from their teachers." How can this situation be reversed? Through visits to museums and science facilities, discussion and advisory groups, seminars, post-school training activities... Over a period of two

years, thousands of youngsters have been introduced to science- and technology-related occupations through more than 130 events. On many occasions, scientists and engineers from various minorities agreed to meet these children, some of whom had limited prospects for the future, and to tell them something of their own story, thus taking on the status of alternative role model.

New initiatives

Based on the information provided by these initiatives, the project team was able to analyse the challenges, and to develop and evaluate methods for improving the situation. The data collected through project questionnaires made it possible to identify the social and cultural obstacles that play a role in holding young people back and turning them away from science. Most of the experiments conducted were widely covered by the national and regional media. "It is very important that marginal social groups be a part of socio-economic progress and achieve better social cohesion," Miroslav Polzer, director of the Austrian Science and Research Liaison Office (ASO) in Ljubljana, told the BBC. "Broadening ethnic minority access to science and technology education is vital for the growth and development of society as a whole." Completed in 2005, the *Ethnic* project inspired new initiatives in many countries. Meanwhile, the Slovenian and British partners are carrying on with the development of tools, primarily training guides. "Increasing the potential of Europe's human resources in science and technology," Elizabeth Rasekoala told the Science & Society Forum organised by the Commission (Brussels, 2005), "cannot be done without considering their characteristic diversity. Ethnic minorities constitute a significant proportion of these resources. Society has to take that into account and work out ways to include them."

Cyrus Pâques



www.bit.ac.at/ethnic
http://ec.europa.eu/research/star/index_en.cfm?p=02_main



A question of culture...

On the banks of the Gironde River in Bordeaux, the former dock-side warehouses have been converted into urban spaces. Blending in with this industrial-esque landscape is a newer concrete building. This is Cap Sciences, a friendly, multi-functional place designed for hands-on exploration.

Located at Hangar 20, Cap Sciences houses exhibition spaces, a café with a view of the river, and spacious offices. It is also home to an enormous workshop where tables, display cases and materials used in activities are put together and where metalworkers and costume-makers drop in to lend a hand. Impressive black crates containing exhibition materials in kit form are awaiting departure – some are on their way to Greece, while others are heading for Turkey. A group of school children unpack their lunch in the cafeteria. In the media library, some young people are engrossed in documents. On the first floor, Bernard Favre's team is planning the next exhibition, for 3- to 6-year-olds. "The theme is measurement. This is not an

easy topic, especially for young children⁽¹⁾." The exhibition will therefore be based around the theme of a journey, like in the story *Thousand and One Nights*, taking a detour through Islamic art in order to help the children discover geometry. "Even for the youngest visitors, our approach is always to place science within the context of the history of civilisations." Multidisciplinary in nature, the preparatory work involves mathematicians, speech therapists ("who are very familiar with the difficulty children have in distinguishing numbers"), psychologists ("measuring your height, or your shadow, is also a way of comparing yourself to others and understanding what it means to be bigger or smaller").

Young researchers as guides

On the ground floor, school children are immersed in the *L'eau à la bouche* exhibition on water consumption. The programme is both factual and entertaining. "The word 'experimentation' is not just about something done in school. It is also associated with exploration. Both of these awaken our curiosity – and science is about discovery." When they come out of the exhibit, the children will know more about groundwater, and, for example, the number of kilometres that many African women have to walk to reach water, water wastage and pollution, the number of litres it takes to fill a bathtub, the possibility of desalinating seawater, and conflicts and wars surrounding possession of this vital resource... Classes spend a half-day or a whole day here. Students and teachers are taken through the exhibit by guides, who present various parts of the exhibit, lasting around 20 minutes each. There are some 40 students and young researchers acting as guides, according to their expertise and availability. "Being ten years older than the pupils themselves, these students take on the role of a big brother offering another view of science."

A little further on, we come across an exhibition on a recent technological achievement: an operation which was carried out by surgeons at zero gravity (see 'surgery in space'). As the crow flies, the European Space Agency and Airbus are only a short distance away. Some of the initiatives are launched with support from industry. Nestlé contributed to the water exhibition, while other industrial partners have supported events on digitalisation and on new materials. "Whether the support is public or private, the rules are the same. We decide on the content and way it is presented."

Exchanges and languages

In a few days, *Fascination of Light*, a German exhibition that started in Brussels, will open. As is the case with many science centres, the Bordeaux facility creates its own exhibition, which it can then 'export', while also 'importing' and adapting others. This practice makes it possible to vary the exhibitions on offer and to benefit from the research, creative work and setups of other exhibitions that would otherwise not be possible because of space and time limitations. Its success is thanks to

Surgery in space

In September 2006, a surgical team operated on a person with a fatty tumour on the forearm. Nothing extraordinary about that. Except that the patient was a volunteer and that the operation took place on board an Airbus A 300 in zero gravity. Based in Bordeaux, the aircraft dubbed Zero G is one of only two in the world making parabolic flights (involving freefall descent followed by a dizzying climb), which are able to recreate gravity-free conditions for approximately 40 seconds. For three hours, the aircraft recreated these conditions 32 times. The accumulated time enabled doctors to operate on their patient for a total of approximately 10 minutes.

The operation was successful.

A mock-up of the aircraft, the operating suite and the onboard medical equipment are on display at Cap Sciences. Various videos, including those shot during the flight, provide more information about this unusual experiment, which is an essential one for the safety of astronauts living in space stations for months on end.

the interpersonal exchanges taking place primarily through the *Ecsite*⁽²⁾ network. "Having a network is important. It is thanks to these connections and co-production and co-distribution methods that European cinema is able to thrive. The interpersonal exchanges are very positive. On the other hand, exchanges of products often pose certain problems. The first is the linguistic problem. Everything needs to be translated, including the multimedia components. In this regard, we have little or no help from the European Commission, which could provide very welcome support. For example, we are only able to exhibit *Fascination of Light* because the Belgians had translated it into French."

Praising alternative choices

Set up in one of the centre's corridors is a portrait gallery containing a collection of black and white photos of researchers. On a counter-top, bookmarks are scattered featuring the faces of young scientists, briefly explaining their work and motivations. For Bernard



Favre, young people are interested in science, and most studies show that the degree of confidence in researchers is quite high in Europe. "There is, however, a gap between this taste for science and the wish to make it a career. The studies are not easy and the remuneration is often much lower than in sectors such as business and finance. This could dampen anyone's interest in a career in science."

But Cap Sciences is not only for teenagers. Older children and adults are among its visitors, too. Some evenings are set aside for the *Science Caf  *. Bernard Favre thinks it's a shame, however, that these are not more like philosophy caf  s, where no one guest is invited, only a philosopher who initiates the discussion. "We invite scientists but we do not impose our cultural policy on the debate. We want to elicit curiosity, interest and exchange. It is not about, for example, knowing if you are *for* or *against* GMOs or about counting tallies after the discussion. It's about being better informed on the concepts of risk, methods, etc. If we are able to stimulate people to delve more deeply into things, whether it be through a meeting or an exhibition, then we have won our bet. To help people interested in the arts, for example, to discover mathematics through music or the visual arts seems to us to be an excellent way of achieving this."

Didier Buysse

(1) All quotations are by Bernard Favre.

(2) See p. 26



www.cap-sciences.net

10-minute surgical intervention
in zero gravity...

Humanities on the move

Each year, Cap Sciences organises a festival entitled the *Theatre of Science* that promotes the humanities. The year 2007 is dedicated to language. The following quote by French writer Victor Segalen has been chosen as a caption for the event: "It is best not to go off on an adventure without taking some words along." As part of the festival, conferences, debates, and film screenings followed by discussions have been organised throughout the Aquitaine region. These events involve the participation of neuro-linguists, psychoanalysts, anthropologists, sociologists, speech and communications specialists and theatre actors, all providing their expertise to the most wide-ranging aspects of language: different languages (human and animal), linguistic diversity (more than 6 000 languages are spoken today), dialects and jargon, the relationships between language and cultural identity, 'talking' robots, as well as gibbering and non-speak that emerge during therapy. Events include a performance paying homage to silence by Patrick Baudry, a sociologist at MONTAIGNE University in Bordeaux, while screenings of the astonishing French film

L'Esquive (*Games of Love and Chance*), directed by Abdellatif Kechiche, will provide an opening for discussions on the language of adolescents.



  Cap Sciences

AND BRIEFLY...



Play and decide

GMOs, nuclear energy, avian flu...

How can we form an opinion on these topics? By basing our opinions on information. How do we assess this information?

By discussing it with others.

That, in a nutshell, is what the *Decide* project is all about.

The original version of this debate game is virtual: you enter the site, read the rules, choose a topic, download the information packs, form a group to discuss the subject on the basis of the information provided, and go back to the site to send in your conclusions.

This 'mini citizens' forum' game is played by groups of 4 to 8 people (children are allowed),

lasts 80 minutes and requires a moderator. The six subjects include leading-edge research, new technologies and social issues like HIV AIDS, nanotechnology, neuroscience, PGD (pre-implantation genetic diagnosis), stem cells and xenotransplantation (animal to human transplants).

For each topic, there are cards with reference material, including a scientific explanation (with a scientist's face for added authority) and arguments on the subject from holders of different ethical/social/political/economic

positions. There is no black and white here, only a shade of opinion. At the end of the game, the players upload the results of their debate. To find out what other people think, you can return to the site to view and compare the opinions of different groups of players in Europe.

For a few years now, five countries (NL, EE, PL, AT, PT) have been moving the game onto a different plane, organising 'Playdecide' sessions in science museums.

A dozen other countries have since followed suit.



www.playdecide.org



European students and research scientists, projects established in developing countries.

"Imagine all the people..."

Not just two birds killed with one stone, but three! The school competition *Imagine Life Sciences* is based on a three-sided approach: involving scientists in educational and social projects, trying to interest students in the realisation of such projects, and bringing new technologies to developing countries.

How is this done? Researchers in the life sciences are invited to present affordable technological projects designed for developing countries. Teams of 2 to 5 students (16- to 18-year-olds) choose

a project and have to devise a business plan to implement it. The school teams work with the scientists and development experts to study the feasibility of their project before presenting it to a jury. The winners will see it put into effect, and will visit the country in question.

Three years down the road, *Imagine* has implemented a number of projects taking research from the lab to the field. Examples of projects are the creation of biofuel from algae in Mozambique, and the production of new products, especially oil, from avocados in the Dominican Republic. This latter idea, which came from the Netherlands, has proved extremely successful and has been adopted by several European countries.



<http://foundation-imagine.org>
info@foundation-imagine.org



The young Spanish astronaut Pedro Duque, invited by *Ciência Viva* to talk about his experience in space.

Portugal – the impact of *Ciência Viva*

Ciência Viva was launched in 1996 by José Mariano Gago, formerly of CERN, now Portuguese Minister for Science and Education. In its ten years of existence, the initiative has supported more than 4 000 education projects

affecting over 600 000 children and 7 000 teachers, as well as events intended for the general public: exhibitions, activities, astronomical observation, geology walks, not to mention a project, focusing on lighthouses, which throws light on an important cultural aspect of a country whose face has always been turned towards the ocean. For Rosalia Vargas, director of *Ciência Viva*, one of the most important lessons of these programmes is the closer communication between the scientists and the general public, who increasingly want to be able to discuss the repercussions of science on daily life, be it in the fields of health, the environment or the economy.



www.cienciaviva.net

The Wonders Carousel

EUSCEA (European Science Events Association) organised the first European Science Festival in 2006. Known as *WONDERS (Welcome to Observations, News & Demonstrations of European Research and Science)*, this event takes place in 20 European cities plus Jerusalem. In each country, thanks to a system of exchanges called the 'Carousel of Science', the organisations involved send three activities to other partners, while receiving others in return. Picking any point on the network will thus turn up a variety of activities with intriguing titles, such as *A Murder at the Museum*, *Octopus* and *Dr Molecule*.



www.wonders.at/



Examples of excellence

"It seems to me that it is because most researchers do not have sufficient personal commitment that they have so many problems in expressing themselves. Jobs in science have become increasingly technical and less intellectual. Today's young scientists are much better trained in their specialist areas than before, but this development has been to the detriment of objective criticism. However, being an intellectual means being involved both in the production of new knowledge and in the critical reflection on it; these two things have always been inseparable in philosophy, literature and the human sciences... On the other hand, these two elements, that of creation and criticism, have been gradually separated in the scientific approach to natural sciences."

Jean-Marc Lévy Leblond
Theoretical Physicist

A science teaching fair

“How do you tell the difference between a hard boiled egg and a raw egg without breaking it?” asks Zoltán Köllő, a teacher of physics and technology at the Illyés Gyula secondary school in Budaörs, in a bid to draw the curious-minded to his Hungarian stand. At the Science on Stage fair, organised by EIROforum⁽¹⁾, this is exactly the kind of banter that greets visitors. In marked contrast to the muffled atmosphere of traditional seminars and conferences, this event is above all a fair, offering a whole variety of exhibits and on-stage events designed to present the most innovative practices in science teaching.

How do you keep your pupils awake?” That is the question Ulrike Bomschein raises at a neighbouring stand. Slightly provocative perhaps, but a familiar problem for the teachers who make up the majority of the fair’s 500 visitors from 28 countries. All over Europe, school pupils of all ages too often have an image of science lessons as being dull, drab and difficult. “My solution? A big ‘bang’ that wakes them up!” jokes Ulrike. But it’s not just any bang, but the bang from the Gauss cannon – an electromagnetic device for the acceleration of metal projectiles – that she

built together with students from her science classes at the Robert Koch secondary school in Berlin. “The idea came to me when I saw how fascinated my pupils were by magnets,” explains this young teacher.

Toilet paper provides the proof

Fascination is a word frequently used at this science teaching fair. From the very youngest age, physical, chemical and biological phenomena have something magical about them. The Austrian stand, for example, displays examples of questions asked by primary school pupils about the sun: “Why is it yellow?”, “How

does its heat reach us?” and “Why is it hotter in summer?” Naïve as they may sound, these are all inherently fascinating questions. The whole art of teaching lies in keeping this curiosity alive through experiments that become increasingly complex. “One of the greatest motivations for learning about science is to be faced with a disconcerting paradox,” believes Joseph Trna, a secondary school physics teacher and visiting professor at the Masaryk University (Brno, CZ). He promptly takes from his pocket a roll of toilet paper, tears off a few sheets, which he uses to block up the central cardboard cylinder, tapping it at one end. ‘You see, tapping makes the ball of paper move further in rather than pushing it out. How do you explain that?’ asks this jovial author and creator of a CD ROM entitled *50 physics experiments with toilet paper*.

Chemistry and the alchemists

One would be wrong to regard such demonstrations as mere tricks designed to grab the attention of pupils. Behind each of the experiments presented at *Science on Stage* lies an in-depth examination of science teaching. “I have always been struck by how pupils in chemistry classes reason like alchemists from back in the Middle Ages who believed in the transmutation of elements, when any chemical reaction is a progressive transformation and not a rapid transmutation,” explains Isabelle Marini of the University of Pisa (Italy). Inspired by the words of the American philosopher and educational reformer, John Dewey, who believed that “words only acquire any meaning when we discover this meaning in our concrete interaction with things”, Isabella developed an experiment that allows secondary school pupils to discover enzymes for themselves... using a few grains of barley, iodine dye and a little saliva! The salivary enzymes break down the barley starch, causing the iodine dye to change colour from blue to pink. By subsequently varying the saliva concentration, the pH or the temperature, pupils are able to discover enzymatic catalysis for themselves.

Choreography and mathematics

Other experiments are inspired by the ‘constructivist’ movement, which believes that pupils progressively build their understanding of the



The Hungarian stand



An astrolabe reproduced by pupils at the Edouard Branly secondary school, in Créteil (France).

outside world on the basis of their own experiences. Although unaware of it, many of the activities in which adolescents engage contribute to acquiring such knowledge. Examples are sport, music and dance, all of which require an implicit understanding. "My pupils who do an 'ollie' on a skateboard are very much aware of what muscles they use in performing this acrobatic movement... but they do not know their names or how they contract," explains Consolata Piscitiello of the *Istituto Superiore Statale Liceo Alfitano I* in Salerno (IT), where she runs a "science and sports" programme that combines mechanics and biology. Ernst Schreie of the Droste-Hülshoff secondary school in Freiberg (DE) applies the same approach to his lessons in wave physics using music as the starting point, because "physics and music are closely linked through the study of mechanical vibrations and waves". At its stand, the Finnish delegation presents a multidisciplinary project, developed in partnership with the National Ballet of Finland, which seeks to study mechanics on the basis of classical ballet movements. "What is *fouetté-pirouette*? It is the conservation of angular momentum! And *pas de deux*? That movement represents a displacement of the centre of mass," explain the teachers as they watch the ballet videos that their pupils must analyse.

Richard Spencer of Bede Sixth Form College in Billingham (UK) uses dance for a completely different teaching purpose. The first biology dance evolved after a lesson on

mitosis. "I'll never forget the moment when – after experiencing the theory, a video, computer animations, a root tip squash practical and a simulation using pipe-cleaners – a student declared he still "couldn't grasp it"! I started to explain using my hands and fingers to simulate the movement of the chromosomes in mitosis and concluded "it's a bit like a dance". And it became a dance – the Mitosis Mamba – a set of hand actions set to music". This is an excellent example of what dance teaching theorists refer to as learning 'through using the body'. This same approach is also adopted by Dragos Constantinescu of the Valcea secondary school (RO) who, at the Romanian stand, displays the repertory of songs he composed with his pupils, the words to which are mathematical theories and formulae.

The roots of the astrolabe

At the French stand, however, it is the theories of Jean-Marc Lévy Leblond and of 'science as culture' that provide the inspiration. Two guys, looking rather like rappers, stroll around *Science on Stage*, each of them wearing a curious circular, golden and finely chiselled object around their necks. So what is it? 'An astrolabe,' Steve Clamy and Steeve Samba, pupils at the Edouard Branly vocational training secondary school in Créteil (FR), reply in unison. An astrolabe? "Yes, they were used by navigators in the Middle Ages to calculate time and trace their route. They were built by learned Arab men of the 9th century and based on ancient Greek astronomy." During one school year,

pupils successfully built their own astrolabe at the school technology workshop, after studying the theoretical foundations of its workings in physics lessons and the origin of this remarkable instrument, which is now forgotten in history lessons.

Experiments, shows and exhibitions, all designed to intrigue, amuse and above all provide food for thought... that was what this five-day fair was all about. "Curiosity is in our genes," declared Science and Research Commissioner Janez Potočnik at the event's closing round table, "but this curiosity tends to die away as we grow up. We must awaken this dormant passion, and initiatives like *Science on Stage* can be a very effective alarm clock." But what about those eggs? The answer is to spin them around, then briefly stop them by placing your finger on top. The egg that starts spinning again is the raw one...due to the inertia of rotational movements in liquids. "It is more than magic, it's physics!" exclaims Zoltán Köllő.

● **Mikhail Stein**

(1) This second Science on Stage festival was held in Grenoble (FR) from 2 to 6 April 2007. It was organised at the initiative of EIROforum, a grouping of seven European scientific organisations: CERN, EFDA, ILL, ESRF, EMBL, ESA and ESO. To find out more about these organisations see the special issue of RTD info, February 2007: http://ec.europa.eu/research/rtinfo/pdf/rtinfo_special_eiroforum_fr.pdf



www.ill.fr/scienceonstage2007

Conquering the universe... of youth

The blue planet, seen from the Soyuz spacecraft, photographed by astronaut André Kuipers. An adventure that could generate ideas?

In an age when there is no terra incognita left on the surface of the globe, space is one of the last refuges for man's exploring instincts. It is also a powerful stimulus to the imagination, particularly for the younger generation, which is notoriously fascinated by the mysteries of the universe. The European Space Agency (ESA) is determined to nourish and foster this fascination through an astonishing diversity of educational and cultural activities.

With its *ESA-Kids* site (www.esa.int/esaKIDSen/), the European Space Agency opens its doors to children as soon as they are old enough to master the basics of using a computer. The site offers all sorts of activities, often divided into several levels, so that children can learn while playing. There are, for example, multiple-choice questionnaires in six languages on topics as varied as 'What is gravity?' and climate change. Jigsaw puzzles are there to be assembled, with pictures of the ISS (International Space Station), the galaxy NGC 4449 and an infrared snapshot of *La Niña* – the oceanographic phenomenon associated with climatic anomalies. There is also a news bulletin in the form of brief reports linked to corresponding games. Furthermore, there are colouring books for toddlers, interactive games, explanations, free wallpaper and screensavers.

From education kits to summer school projects

For older children, there are a number of supplementary tools: for example, the ISS Education kit, which is designed for 8- to 10-year-olds (there is also a version for 12- to

15-year-olds), and which is available to teachers at no charge. This kit, in the form of an A4 binder pack which was prepared in collaboration with teachers and tested in classroom use before being launched, contains all sorts of multimedia material, interactive elements and posters, as well as a teacher's handbook to enable the instructor to get the most out of it. There is also a 'mission possible' kit, for primary school children, with all kinds of exercises and activities.

High school students have at least as much made available to them. One example is the astronomy exercises that ESA has prepared in collaboration with ESO (European Southern Observatory) and which are available online. Here, young enthusiasts can get their first taste of space science research. These are downloadable files of not more than 10 MB (there are also smaller, lower-resolution versions) with all the original data, supplied by ESA, for solving a real problem, as well as the methodology leading, step by step, to the solution. High school students can thus, for example, measure the angular expansion velocity of the Cat's Eye Nebula by comparing two images taken by the Hubble Space Telescope in 1994 and 1997 at certain wavelengths. A special site devoted to

observation of planet Earth (www.eduspace.esa.int/), combining geography, physics and chemistry, is available in six languages. ESA also supplies images that can be used as back-up material (education images) and, more generally, periodically offers space science training activities for teachers.

Then there are the university students, who are given special attention by the agency as the breeding ground for tomorrow's space scientists. For them there are all sorts of workshops, conferences, summer courses and work-experience opportunities. Some student associations can join the *ESA Education* programme directly, or form partnerships with that initiative. Job offers and scholarships are regularly advertised online. To learn more, just set out on your own exploration of this site, where a wealth of welcoming worlds awaits the apprentice space traveller.

Yves Sciana



www.esa.int/esaKIDSen/
www.eduspace.esa.int/
www.esa.int/esaED/index.html

Training through and for research



Young scientists work for three or four years at EMBL to earn a doctorate, which is awarded by their home universities.

Can doctoral candidates still be considered students? Or are they already research scientists? A programme established by the European Molecular Biology Laboratory (EMBL) offers a solution to this false alternative and produces an impressive 50 doctorates a year.

Every year, more than 500 candidate files from all over the world land on Anne Ephrussi's desk. The first – and perhaps the hardest – task before the Dean of Graduate Studies at EMBL is to whittle them down to a hundred, the number of applicants who will be invited for a week of evaluation. "This initial selection is very difficult. We always have a great many excellent candidates, and we cannot take them all."

The procedure of this evaluation week is well established. Each student has already been asked to designate two areas of interest from the various units at EMBL's five sites – Heidelberg and Hamburg (DE), Grenoble (FR), Monterotondo (IT) and Hinxton (UK). Within each unit, team leaders interview the applicants individually, take them around the laboratories, and ask them to rank their choices. After this, a final interview tests the depth of the candidates' knowledge of their subject. Once this selection process – which is designed to match the students' wishes to the needs of the team leaders – is complete, 50 students will be offered either an EMBL bursary (about € 1 800 a month), if they come from one of the 19 participating Member States, or some

other form of financial assistance, such as Louis Jeantet Foundation bursaries for students from Central European countries. "This very selective recruiting system is a key factor for EMBL since the team leaders, often very young themselves, may not be in a position to attract the most experienced post-docs. This means that they try to choose doctoral candidates who will build up the scientific reputation of their group," Anne Ephrussi explains.

The path to a PhD

The lucky few begin with two months of intensive work in Heidelberg, EMBL's central laboratory and the most important for fundamental research. The 350-hour programme includes lectures, discussion groups and practical work on the fundamentals of molecular biology. The object is two-fold: to give students with different undergraduate backgrounds a common foundation (this is particularly important for those with degrees in mathematics and physics) and, above all, to create a 'class spirit'.

"Getting to know all the other students in my year on that pre-doc course was the best possible way to start my PhD," says Johanna

Höög, a Swedish doctoral student at EMBL. After completing theoretical training, each candidate drafts a research proposal and submits it to the Thesis Advisory Committee, which comprises a direct supervisor, who will monitor the day-to-day work, two other EMBL scientists and a professor from the home university. Once the project has been approved, the students set out on a superb adventure: during the course of the next three to four years they will conduct original research and write a thesis that will have to be defended publicly. During this time they will, of course, be guided by their advisors, to whom they will make regular reports on the progress of their work; but they will also experience the thrill of being fully qualified participants in the world of scientific research.

The title of PhD is at stake. The EMBL has been entitled to award the prestigious degree since 1997, and does not abuse this prerogative. "The mission of the EMBL is to foster collaboration between molecular biologists in the Member States. That is why we prefer this system of co-supervision and co-awarding of degrees jointly with our partner universities," Anne Ephrussi continues.

To date, 26 agreements with universities in 18 countries have been concluded. Not without difficulty, however, for the conditions under which these degrees are awarded vary considerably from country to country. At the end of the day, common ground is generally found, for the greatest good of all concerned, including the faculty. As the Dean of Graduate Studies notes, "Having professors from the affiliated universities present on a thesis advisory committee has often been the starting point of interesting new scientific collaborations." ●

Mikhail Stein



www.embl.org/training/phdprogramme/index.html

Education in fusion



The players in the fusion game

Euratom, EFDA, ITER... These three acronyms mark the long history of research into nuclear fusion. Signed in 1957, the Euratom treaty regulates cooperation between the European States on nuclear research in general: fission, fusion, treatment of waste. Created in 1999, the European Fusion Development Association (EFDA) is an association of 29 European institutions that conduct research in the field of nuclear fusion; its principal missions are to organise research at the Joint European Torus facility, near Cambridge (UK), and develop links with industry. ITER was set up by an international treaty signed last December between the EU, China, Japan, Russia, the United States, South Korea and India; EFDA coordinates Europe's participation in the research it conducts.

Based on this analysis, the European Fusion Development Association (EFDA) is developing an active educational policy aimed at students and teachers. It has produced brochures, FAQs and multimedia activities. Its website is a valuable resource centre of text, photos, activities and CDs for understanding the issues involved in the harnessing of 'solar energy': energy released by the fusion of two light atomic nuclei, rather than the fission of a heavy nucleus, which is how today's nuclear reactors work.

This communication policy is not independent of political considerations. European public opinion is profoundly divided on the matter of the civilian use of nuclear energy. A Eurobarometer survey published last February indicates that only 14% of Europeans are in favour of increasing the share of nuclear energy in the Union's energy package. One in five respondents, however, would change their minds if they could be assured that nuclear energy does not produce greenhouse gases

and would reduce energy dependence. Nuclear fusion would share those two advantages, and have the further advantage of not producing long-term radioactive waste. Fusion therefore offers very real advantages, which EFDA intends to make better known. The least one can say, however, is that it has its work cut out for it. While 58% of Europeans had heard of nuclear fusion in 2006, only 9% knew the name ITER.

A master's of choice

This ignorance of the future flagship of global fusion research is all the more regrettable since the project will be spending some € 10 billion over a period of thirty years and will employ a thousand scientists at Cadarache alone, all of whom have to be trained. A challenge indeed for Europe's universities, to which the *Erasmus Mundus* programme is valiantly responding. Instituted in September 2006, the 'European Master in nuclear fusion and engineering physics' offers multidisciplinary training geared to the requirements of the future ITER site.

A 'long-term project for preparing the future'. The expression may be overused, but it still applies perfectly to research in the field of nuclear fusion. Although construction of the International Thermonuclear Experimental Reactor (ITER) at Cadarache (FR) has begun, no one is yet suggesting that this source of energy, which in theory is both clean and inexhaustible, will have been mastered on an industrial scale before the end of the century. Investing in the future also means investing in communication and education.

This diploma, coordinated by the University of Ghent (BE) in association with three universities in Madrid⁽¹⁾, the University of Stuttgart (DE), the Henri Poincaré University of Nancy (FR) and the Royal Institute of Technology in Stockholm (SE), will offer a two-year programme conducted in three countries. "We have received more than 180 candidate applications from all around the world," says Guido Van Oost, a professor at the University of Ghent and the coordinator of the programme, "while we have only 24 bursaries to offer." The initial intake includes only two citizens of the European Union... a fine international acknowledgement of Europe's position as the world leader in the field of nuclear fusion research. ●

Mikhail Stein

(1) The Complutensian University, the Carlos III University and the Polytechnic University.



www.em-master-fusion.org
www.efda.org/usercases/students_and_educators.htm

AND BRIEFLY...

Science in school

Launched in 2006 by EIROforum, *Science in School* is a quarterly journal for science teachers. Well illustrated and chock-full of a dazzling variety of material, the magazine is available free of charge in English for teachers, while the on-line version, with several articles translated into different languages, also hosts a discussion site. *Science in School* presents the latest discoveries in leading-edge science, pilot teaching projects, interviews with professors and scientific researchers, and provides concrete teaching material (teaching aids, calendar of events) as well as an on-line chat room.

 www.scienceinschool.org




Catch a Star, category 'artists'.

Secrets of the stars

Catch a Star has just completed its fifth contest. Organised by the European Southern Observatory (ESO) and the European Association for Astronomy Education (EAAE), it is open to schoolchildren around the world. This contest is more than just

a competition. Its organisers see it as an opportunity to encourage young people to take an interest in science, by giving them a chance to gain more in-depth knowledge of astronomy and to work as part of a team. *Catch a Star* has three levels. In the top category, research teams of three students, aged at least 15, plus a teacher, work on astronomy projects of their choice. The winning entry will earn a trip for its team to Paranal (Chile), where team members will visit ESO's La Silla Observatory. A second category allows 'adventurers' to address the same subject more simply, (for instance through a report on a day among the stars). Budding artists can submit drawings to the site, to be judged by site surfers. This year, the research section alone attracted 123 projects from 22 countries.

 www.eso.org/outreach/eduoff/edu-prog/catchastar/

A gem of a website

Curiosity is a great thing, and the website of the CNRS (the French National Scientific Research Centre, which involves 30 000 scientists) serves it admirably. This is popular science at its best: it includes pages for the general public and for young people, images, a multimedia library, special reports, science and decision-making. In the context of the International Polar Year, the virtual *Journal des sciences* offers a journey "with the research team to look for answers on the Earth's fate". Magazine articles report on fieldwork and life in the lab. Since all domains are represented at CNRS, you can move from mediaeval archaeology to fibre



The CNRS in the polar regions.

optics by way of the false trail of mitochondrial DNA. These pages, packed with information expressed in clear, plain language, provide secondary school teachers and students with a wealth of useful material for preparing lively and well-documented classroom and written work.

With one click, visitors can also enter an astonishing collection of educational images arranged by category – physics, chemistry, life sciences – with very specific information files (illustration, concise explanation, links). Anyone wanting to understand, for example, what a vegetable organism is, may find themselves embarking upon a fascinating adventure of knowledge, and developing an interest in cells, vacuoles and chloroplasts, before jumping on to photosynthesis and genotype. The combination of information and image is bound to whet your appetite for both knowledge and images, and keep you coming back for more.

 www.cnrs.fr

The world of CERN

CERN, its site straddling the border between France and Switzerland, is the world's leading centre for particle physics research. What CERN's physicists are attempting to do, armed with their particle accelerators and other

giant machines, is to recreate the conditions that existed at the very beginning of the universe, and to study the very smallest components of matter.

They are also great communicators, and are eager to share their passion and their investigations into the mysteries of the cosmos.

For children, they have devised 'Fun with Physics' workshops and multimedia games with guides like comic strip heroes, who invite them to taste their liquid nitrogen strawberry ice cream before setting out in search of cosmic rays, antiprotons, quarks and gluons. The whole site visit package is also available on-line, via the interactive centre Microcosm.

For teachers, CERN has a whole package of activities, presented in three-day or three-week summer programmes. These include conferences, workshops, lab visits and discussions designed to help them keep in touch with what is going on in physics research and perhaps pick up some new ideas for their lessons. There is also a wealth of teaching material available on-line and CERN, of course, is one of the partners in *Science on Stage* (see p. 38).

 www.cern.ch

<http://public.web.cern.ch/Public/Content/Chapters/Education/Education-en.html>

Visiting a particle accelerator.



