The scientist between Superman and Frankenstein
Science and scientists in the drawings of European children

Paola Rodari

Drawing is a very powerful instrument in the analysis of children's imagery. Drawings may reveal a lot, as they are spontaneous, immediate and a receptacle for small pieces of children's knowledge (concepts, notions, information) and "popular" culture (books, comic books, cartoons, films, TV programmes).
Obviously, one should not think that drawings are able to reveal everything children know. In fact drawing complies with a specific communication code, which has its own rules, symbols, icons and consequently it somehow frames (and limits) narration. As much as when a child draws a "house", that drawing does not contain everything a child may think and know about a "house", when a child draws a "scientist", he/she is necessarily using a number of codes pertaining to the act of drawing, for example, very often, stereotypes.
On the other hand – especially as far as young children are concerned – most probably a lot of ideas can be materialised in a drawing, while they are not translated into verbalisation yet.
If what is portrayed in drawings may still be highly representative of what a child thinks, this may not apply to adolescents or young people, who may have a richer idea of science but who may use, while drawing and because of the media, stereotyped images, as for example the icon of Einstein or of a "crazy scientist". Moreover, teenagers from 12-13 years old normally cease to draw and to feel drawing as a satisfactory and familiar means for expression, so their drawings are less interesting. Some of the adolescents refused to produce a drawing, only to fill in the questionnaire. Therefore, the number of drawings we have collected is slightly inferior to the number of filled forms (1,102 instead of 1,158). In figure 1 the distribution of our sample per countries.

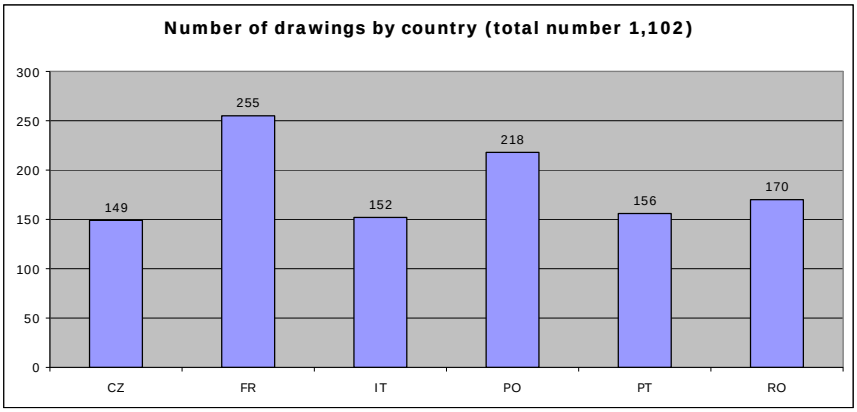

Figure 1. Number of drawings by country (total number 1,102).

Structure for the activity and methods for the analysis

The pupils were given the task to draw “a person who works in science”. In fact, the word “scientist” has a gender connotation in all the languages SEDEC involved, whereas one of the issues to be analysed was the frequency of the association scientist=male – and how frequently children imagine researchers as women.
As regards the analysis methods, the drawings were all inserted into a database implemented in the internet by the IT technicians from Sissa Medialab, through which the drawings could be tagged with an unlimited number of key words. The key words were used to describe the drawings, and to trace their themes, objects or classes of objects and recurring images.
After they had drawn “people making science”, children were asked to write a title for the drawing on the questionnaire. Not all of the children wrote something: more than one third left the space blank (373), so that only 785 self-descriptions of the drawings were gathered.

Figure 3. “Scientist who is digging type”, Czech Republic.

Women in science

Do children and adolescents think that women can make science? Apparently yes, and curiously the percentage of women scientists in the drawings (the average is approximately 25%) is not far from the real one, considering the European context.
Women scientists are definitely more present in the drawings by the Romanian children (41%), drawn primarily by girls: 62 out of 70. Women are less present in Portugal (34%) but they are drawn also by boys (18%). France ranks third (21% of women scientists), followed by Poland, Italy and the Czech Republic. However, in Poland 13 boys (13% of the pupils) depicted a woman scientist (out of 42 drawings of women scientists), whereas both in Italy and Czech Republic not only the presence of women scientists is scarce, but they are depicted nearly exclusively by girls (figure 2).

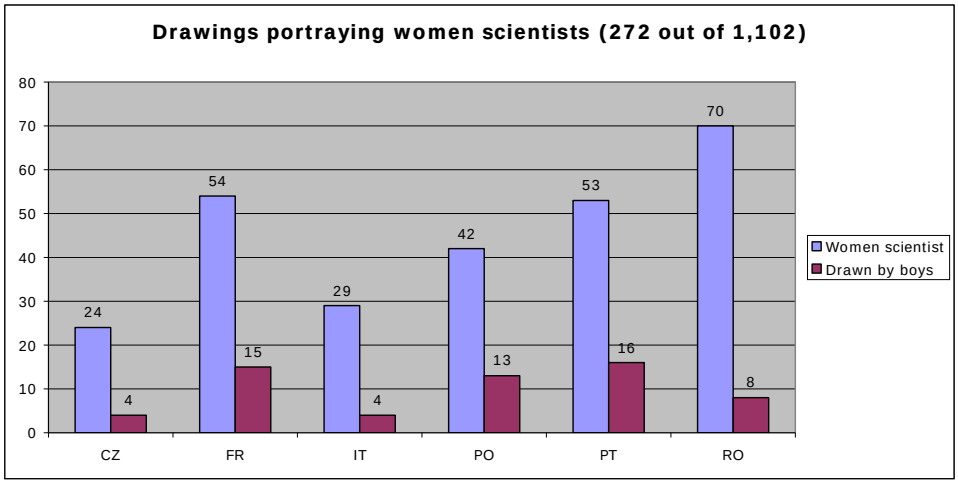

Figure 2. Drawings portraying women scientists (272 out of 1,102).

In general, women scientists are portrayed as good-looking, well-dressed women, and sometimes really sexy (cf. figure 3). Children seem not to consider making science exclusively as a male job (but this tendency to an opening decreases as they grow older) and they do not think that, to succeed in this job, a woman has to relinquish her femininity.
Even the descriptions show that girls have a positive image of a woman researcher:

> *"It's a young, self-confident and promising genetic researcher (woman). She is actually working at new method how to treat diseases" [CZ]*

> *"The young lady, just after graduating, very clever, broad-minded; she'll be a perfect scientist." (PL)*

A Romanian girl from a primary school (and she is not the only one) sees a woman also as a manager:

> *This woman is the boss of the science department (lab) (RO)*

Two descriptions (from secondary schools, and not by chance) reveal the conscience of a possible inequality between genders in the research field, but the authors take it as a negative thing. A Polish girl has written:

> *"The lady scientist - there should be no woman discrimination in this profession." (PL)*

In the same class, a boy has stated:

> *"The young woman (the science should be made by young, open-minded people; the development of natural sciences, physics and chemistry is important)." (PL)*

The triumph of chemistry and the stereotypical image of a scientist

The drawings in our sample clearly reveal a stereotypical representation of a scientist, conventionally shared – and this is not casual – by comics, cartoons and many books for young readers, and also presented in films and TV series: the scientist wears a white coat (359 occurrences, about 33% of the sample) and glasses (352 drawings), works in a laboratory (322 drawings, nearly 30%) and dabbles with test tubes or mainly with liquids (cf. figure 4). Hence, science appears primarily as an experimental activity (as confirmed by the analysis of the questionnaires) and the most drawn instruments are those of chemistry, appearing in 392 drawings (about 36% of the sample). Even when children – many of them – only draw a scientist (without an environment), they are shown wearing a white coat in nearly all cases and, very frequently, holding a test tube or a backer.

Figure 4. "The scientist trying to invent an element, thoughtful, surrounded by things he studies". Poland.

Very often the term 'chemistry' appears in the description of a drawing that does not show any evident "traces" of the discipline: by adding the drawings containing chemical instruments to those with a title referring to chemistry, the total number is 489, nearly half of the sample.

One cannot say that children do not know that sciences other than chemistry exist, but probably this knowledge is too generic, without any image or detail linked to it. When they have to denote science through a drawing, children do not have a vast repertoire to draw images from and use chemical instruments as symbols of scientific research.

Aside from chemistry – which has a massive representation, as shown – the rest of science plays only an extra role: there is a group of drawings that somehow refer to the area of the study of living beings, as biology is explicitly mentioned or there are mainly scientists analysing plants and animals (114 drawings out of 1,102).

Another area is linked to health and it includes the drawings that depict doctors or scientists in search of new medicines (69 drawings), whereas other fields of research are represented by smaller numbers (cf. figure 5).

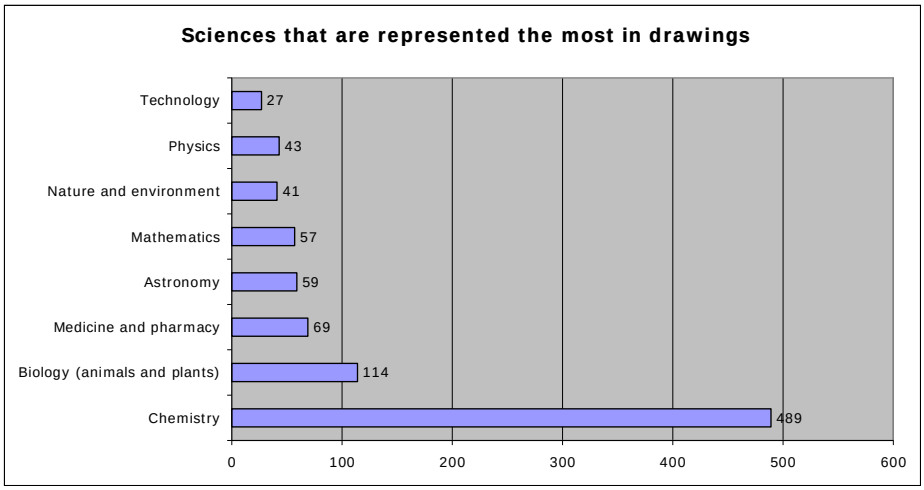

Figure 5. Sciences that are represented the most in drawings.

Astronomy ranks quite well: there are 59 drawings featuring stars and planets or telescopes; actually, better than physics and maths. Yet this result is not casual: 34 drawings out of 59 come from Poland – from a city (the town of Kopernik!) in which our partner carries out a consistent work of dissemination

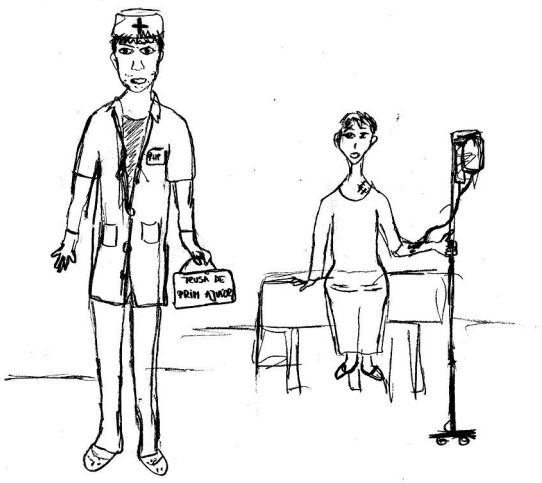

Figure 6. "I chose to draw a doctor because it is a domain I am familiar with, and I find it very interesting". Romania.

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astronomy, whose impact is clearly visible in the drawings.

There are only a few drawings we have considered as "realistic" ones, about twenty in total. Quite interestingly, one of these – which portrays a doctor – was drawn by a boy from a secondary school who explicitly stated he had chosen this subject as he was familiar with it, and therefore he was able to depict it, whereas he would have had evident difficulties in drawing a "geologist" or a "ecologist" (cf. figure 6). This means that limited experience and information – and consequently too few iconographic details – are linked to disciplines, although they are certainly included in the cultural heritage of young people.

Genius and dissolute behaviour: the Einstein icon and crazy scientists

Quite a large group of drawings present an image for a scientist which is strongly reminiscent of Einstein: besides wearing a white coat and glasses, an Einstein-looking scientist has his hair standing on end like the great physicist and a hyper-attentive expression that ranges from genius to craziness.
This applies to 83 drawings, about 8% of the sample, to which 25 explicit portraits of Einstein should be added: in some cases they even feature Einstein's name correctly spelled (figure 7), whereas others have it more or less voluntarily misspelled; this accounts for over 10% of the sample.

Figure 7. "Einstein - the man who invented a lot". Poland.

	Total number of drawings by country	**Disorganised**	**Dirty**	**Einstein-looking**	**Percentage of Einstein-looking scientists**	**The stereotype of the genius scientist***
CZ	149	0	0	6	4%	6
FR	255	26	4	15	6%	45
IT	152	5	1	26	17%	32
PO	218	0	5	30	14%	35
PT	158	3	4	3	2%	10
RO	170	1	0	3	2%	4
TOTAL	**1102**	**35**	**14**	**83**	**8%**	**132**

Table 1. Drawings showing an Einstein-looking scientist, or with a genius-like appearance, disorganised and/or untidy.

	Total number of drawings by country	"Crazy" scientists	% of "crazy" scientists out of the total amount	Drawings that express danger	"Crazy" scientists + danger signs	% of drawings containing "crazy" scientists and danger signs
CZ	149	12	8	6	18	12
FR	255	13	5	19	32	13
IT	152	23	15	9	32	21
PO	218	10	5	13	23	11
PT	158	6	4	3	9	6
RO	170	0	0	7	7	4
TOTAL	**1102**	**64**	**6**	**57**	**121**	11

Table 2. Crazy and dangerous scientists.

The distracted and disorganised genius is a very frequent *topos* in the western culture and children draw on it quite passionately (cf. figure 1).
"The scientists are very busy and have no time for themselves" (PL), wrote a Polish teenager; they are so busy working with their frantic creativity that they overlook their appearance and, in the rush of creation they knock over things, they get dirty and do not care about themselves and the environment they live in.
A Polish secondary school is once again the source for the humorous drawing in figure 8, whose comment reads: "White coat as madman, bald by missing his wife".
This stereotype is apparently an inspiration for secondary school students: 59 Einstein-looking drawings out of a total of 83 and 91 stereo-typical pictures of genius and dissolute scientists out of a total of 132.
A genius and disorganised scientist is not far away from a "crazy" one: a "crazy" scientist is a scientist whose thirst for knowledge goes beyond the borders of reason. Not only does this make him a disorganised or absent-minded individual, but it also drives him completely outside the "normal" humankind; very frequently, a crazy scientist is also a dangerous person, as he puts his scientific interest before his own safety and the one of other people or the entire humankind.

Figure 8. "White coat as madman, bald by missing his wife". Poland.

In some drawings, the term appears in the title (27), whereas in other cases it is the graphic representation that reminds of this icon. Considering also the drawings somehow expressing the idea of the danger of science (as there are weapons or toxic and hazardous materials involved), it can be seen that a relevant part of the sample expresses a sort of mistrust towards scientific research and its consequences (64 drawings with "crazy" scientists and 121 including the ones that express "danger", cf. figure 2).
The relation between Einstein, the dissolute spirit of a genius, and the danger lying in the scientific research is not

a forced deduction of ours. Several examples may be mentioned from literature (starting from Golem), even from cinema and comics, but this is confirmed also by the children's word:

> *"I drew Aistan working in his laboratory and something went wrong and his potion burst and he got dirty" [IT]*
>
> *"It´s a chemist in white coat who does experiments. He has to know a lot of things, he has to be careful because his mistake could have a terrible consequences" [CZ]*
>
> *"The overworked scientist with destroyed clothing and glasses. He's absent-minded. His lab was destroyed." (PL) secondary school*

Figures 9, 10, 11 and 12 are in that respect paradigmatic.
In the case of "crazy scientists" there is not a significant difference as far as age groups are concerned.

Figure 9. "Here is Leonardo da Vinci. Flying machine". France.

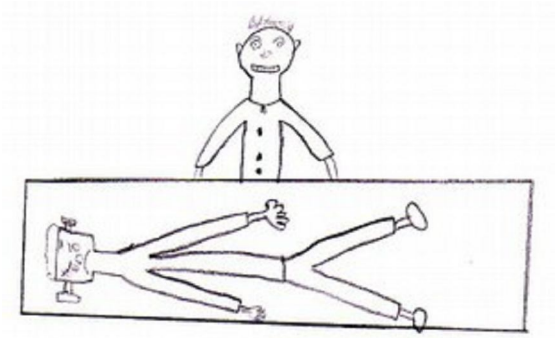

Figure 101. "Albert Einstein who makes the beast live". France.

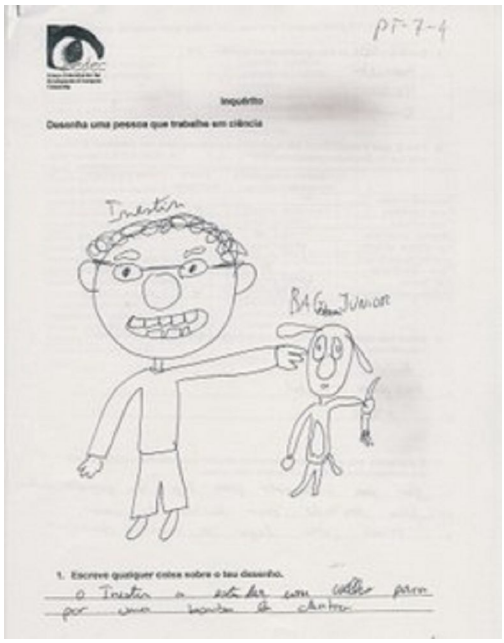

Figure 11. "Einstein and the unhappy explosive rabbit". Portugal.

Figure 12. "The scientist - "crazy" and absent-minded, as each scientist should be". Poland.

Different data correspond to the countries included in our limited sample: the highest number of "crazy" people is to be found in Italy (15% of the total number of drawings! And the drawings expressing danger account for 20% of the total), whereas Romania apparently has a maximum trust in science, being exempt from crazy scientists, and having the minimum number of drawings referring to science as a dangerous things (cf. table 2). The higher level of trust of Romania as regards both science and Europe is also confirmed in other phases of our research.
The scientist sometimes reminds the image of a wizard; and the "crazy" scientist and the sorcerer are close images: actually the image of the "sorcerer's apprentice" is often used also in the media, to connote negatively behaviours linked to the freedom of the scientific research.
In our sample there are 12 drawings whose titles refer explicitly to the preparation of potions and 10 drawings in which the scientist has some features of a wizard (a hat, a gown, or it is explicitly stated that he is a wizard).

The dangers of science

Although they are limited in numbers (less than 10% of the drawings), it is worthwhile to identify what the children's worries as regards science are.
Toxic or explosive liquids, radio-activity and weapons are the issues that worry young Europeans (cf. figure 13) the most: children and young people apparently have "typical" worries, i.e. related to the most questionable aspects of the 20th-century technology, starting from the trauma caused by the Hiroshima bomb and repeated by

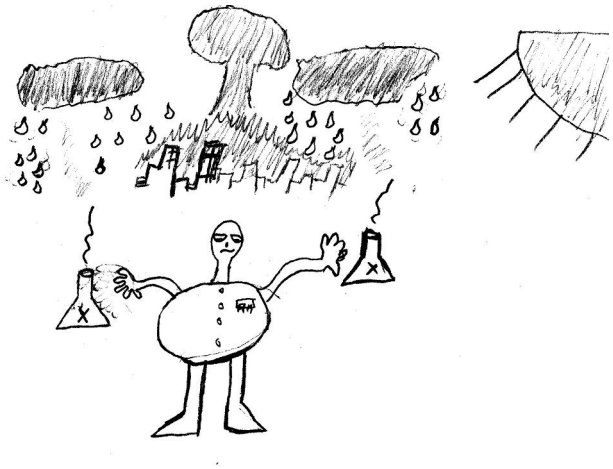

Figure 13. "My draw shows how people pollutes environment because of nuclear research". Romania.

the dreadful accidents (in chemical or nuclear plants) that have marked the past few decades, situations and accidents whose presence is still huge within the mass culture (films, TV series, comics, etc.). There are not (should we say "still"?) traces of more modern worries, already conveyed by the mass media and living – at least partially – within the public opinion, such as the application of biotechnologies or nanotechnologies.
More uncommon, as it is much less frequent in the mass media, is the worry about experiments on animals, which appears in the drawings by French, Italian, Polish and Portuguese pupils. A Polish pupil drew a Frankenstein-looking figure who carries out experiments on a dog. A Portuguese pupil imagined a scientist that puts a bomb inside a rabbit's body. Animals are generally quite a frequent subject (65 drawings; more than in the diverse groups of drawings referring to the different disciplines, except for chemistry), and this worry reveals how much children are fond of animals.

Science as a beneficial element

Having previously considered the fears towards science and scientists as they emerge from the research, this paragraph will now deal with the themes positive expectations are related to and to what extent they are so. There are 50 drawings expressing (in the picture itself or in the description) a resolute appreciation for science as a carrier of progress and as a problem-solver.
The following are the statements by some children:

> *"I think that scientist are illuminated people who develop society. They are essential" [IT]*
>
> *"I wanted to express that science is sinonimous of perfection, experimentation and personal ideas" [IT]*
>
> *"It is a scientist who think of everybody's happiness, and of the well-being of the Planet, and searches the right solution for each specific situation" [RO]*

	Total number of drawings	Scientists benefactors	% of scientists benefactors
CZ	149	5	3%
FR	255	3	1%
IT	152	5	3%
PO	218	8	4%
PT	158	6	4%
RO	170	23	14%
TOTAL	**1102**	**50**	**5%**

Table 3. Percentage of scientists benefactors on the total of the drawnings.

As regards the fields in which this beneficial science operates, there are mainly two of them, as the texts by the children prove: health (21 drawings) and environment (21 drawings). These results are strongly confirmed by the questionnaires, where the majority of pupils express their priority about conserving nature, reduce pollution, etc. Also in the drawings scientists love plants and nature, and they can find solutions to the problem of pollution: collecting rubbish, inventing a way to produce paper "without killing plants" or a non-polluting fuel (pollution is definitely the most urgent problem to them).
Scientists can also find solutions to treat tumours, AIDS, the avian flu; but they can also make hair grow once again on your head and find the formula to immortality: "A scientist who think up a medicament for immortality" (CZ).
Quite interestingly, considering the entire research, there are only a few aspects in which there are substantial differences between the countries involved, and the trust towards science is one of these: the Romanian children have definitely more positive expectations as regards science, as the key word "benefactor" occurs nearly three times over the average of the other countries (cf. table 3, where we are counting the drawings where the positive role of scientists for the good of humanity is strongly expressed). This data is absolutely consistent with the absence of crazy scientists, as previously mentioned.

Conclusions: neither Frankenstein nor Superman

The remarks contained in this article are an attempt to analyse the main impressions emerging from our collection of drawings. Probably a more careful interpretation of the details may provide further information on more specific issues; for that reason the drawings will remain available online for researchers and teachers, in order to allow them to further analyse this kind of issues.
Other considerations may stem from the comparison between the drawings and the context they come from. The general impression is that some classes have produced drawings that are richer in details and lively images, hence showing a better familiarity with science and the scientific practice. In this sense, drawings apparently are a good indicator of the quality and of the typology of the scientific education received,

although the implementation methods for the test may have affected the quality of the pictures.
It can be said that, even though stereotypes can be found in their pictures, all the children were able to draw a scientist, i.e. all of the children are aware of the existence of this universe, which is so important for the material and cultural life of humans. Science as a whole has a considerable presence in it and is connected to an imagery that, after all, is rich and varied.
We have not found important differences between the different European countries involved in the research, a part from a more positive image of science and scientists and a greater expectations about science role for he benefit of Europe in Romanian children and teenagers. As Romania has just entered in the EU, those positive expectations are probably linked to a general trust in a better future from now on.
The most important general conclusion of that part of the SEDEC survey is that a lot of work has still to be done in order to provide children and teenagers of a richer (realistic) image of science and scientists, in order to make them able to understand the impact of science and technology on contemporary society, and of course also to be able to choose or not to choose a scientific career.
A priority issue which should be tackled is the frequent stereotypical image of a scientist; or rather, the set of images – which may even contrast with one another, thought they still remain stereotypical or limitative – that do not represent the diversification in the disciplines or the scientific work, in the professional roles, interests and objects of research. A researcher is not a megalomaniac genius that puts his craving for power before other people's lives; even though, to tell the truth, the techno-science and market system may certainly act in order to put economic interests before those of the individuals or of the environment, and somehow the myth of Golem or of the sorcerer's apprentice may somehow represent this issue. A scientist is not even a superman devoted to sacrifice for the humankind's wellbeing. However, as it is sometimes the case, some scientists really appear as specimens of a superior intellect; and many scientists have really fought, running some personal risks and falling into abnegation, to understand nature or to treat diseases; and yet, the vast majority of the researchers, more or less genius people, really show an inner passion for research that makes them work hard regardless of time, exertion and money.
This bipolar nature of the image of a scientist is very much rooted in our culture; it will suffice to consider the huge – and still persisting – success of the story of Dr Jekyll and Mr Hyde, which contains many aspects of the imagery previously dealt with in this article and is a masterly narrative implementation of the black and white science embodied by this scientist that becomes two different people.
Facing these stereotypical images, an adolescent may rightfully think: perhaps I am not genius enough, or not determined enough, I don't want to sacrifice myself, I want to lead a normal life… I don't know whether I can or want to be a scientist.
They probably do not imagine that a scientist – to be conceived here as anybody working in the field of science and technology – can be a physicist working on the data produced by a particle accelerator, sitting before a computer in a small room, but also an engineer working in a laboratory to devise new techniques to produce a vacuum, or

a botanist working in the “backstage” of a nature museum, studying ancient collections and herbariums, or a mathematician devising models to explain particular aspects of the financial markets, or a biotechnologist spending all of his time in a laboratory, or a geologist travelling around to read the conformation of the ground, or an astrophysicist unable to read a starry sky because he only studies the internal physics of the stars, or a physicist working for a manufacturing industry to optimise its production processes or a neuroscientist cooperating with doctors in the attempt to understand why people are able (or unable when they fall ill) to carry out certain actions.

These are all examples of extremely different types of intellectual and working commitment – only very few cases have been mentioned here and the scope of their working activities is much larger than this – that require a widely-ranging set of characters, dispositions, intellectual abilities and plans for life. And they also employ different instruments and regard different components of the scientific activity.

What has emerged from results is that the strongest component of the scientific activity is the experimental one; also in this sense, the variety in the images of children and adolescents is quite poor: consequently, even making them aware of the actual number of existing telescopes or microscopes may suffice to unveil a fascinating world.

This variety of roles, contexts, personalities, rather than the hagiographic view of a scientist, could be used to inspire young people to a scientific career, and it complies with the suggestion contained in the new work plan “Science in Society” of the seventh framework programme of the Directorate-General for Research of the European Commission:

“Actions to combat stereotypical images of science and scientists; to promote interest in science among young people and to promote realistic role models. Special attention should be paid to gender specific differences and to the needs of young people from disadvantaged, under-represented or underperforming groups. Narrow images of scientists (as portrayed through the popular media for example) need to be broadened to become more representative in order to appeal to young people from a diversity of background.”

For instance, a new and innovative educational proposal has been created within the SEDEC project:

As already mentioned, the problem we are facing is not only about prompting a higher number of young people to embark on a scientific-technological career. The point is also to provide young people with a scientific knowledge linked to contemporary life, so pervaded by science and technology – a knowledge which might come in useful also for those who are not willing to perform a job within the world of research and, most of all, which should make these people aware of the process needed to build a scientific knowledge, of its power and limitations (in a certain sense, the two sides of the same coin), in order to make them participate consciously in the public management of science which, as regards some controversial issues such as the ones mentioned above, not only is desirable, but it is also inevifigure.

Even to achieve this long-term result, stereotypes should be overcome. The image of Dr Kildare busy building semi-human monsters, but also the image of a doctor considered as a sort of saint endowed with the gift of omniscience and omnipotence are extremely

misleading. On the contrary, to consistently follow this example, it would be useful to learn about the way a medicine is proved to be effective, or the conditions for its marketing.
The costs/benefits relationship, the risk management, the precaution principle – and many other indispensable concepts to make decisions in contemporary society, not only as regards medical issues – are essential instruments for future citizens.
Hence, they should be built beyond an environmental education implying a moralistic attitude, which is too often taught at school and which only theoretically promotes some ethical behaviours that are actually ignored by society; i.e., instead of simply being taught that "you must love nature", students should be given the tools to start considering how an environmental issue is to be tackled: by analysing and distinguishing what the current problems are, what the uncertainties and the known factors, what the impacts for the possible solutions, etc.
On the other hand, the concern for the environment is very widespread also among the teachers (see Daniele Gouthier, in that same ibook). And apparently Europe is expected to provide some response. Maybe this could be a good ground to build both a modern scientific knowledge and a European scientific citizenship.
It is positive to talk about the emotions of children, their desires and fears, which need room for expression. At this point we would suggest the use of conceptual maps as a collective activity for classes, to introduce in an involving and surprising way the topics that are to be discussed with pupils.
Indeed, in a class debate pupils often feel they should say what the teacher wants to hear. The conceptual maps, which enable the revelation of thought associations, memories, emotions, are an excellent instrument to set up a really free discussion; whereas at the same time they help the teacher to record the existing knowledge and beliefs.
Debate helps questions to arise, originating a search for answers that can be found through study and experimental activity, but also through the help of experts, the exchange of information and opinions with other European young students (thanks to the European programmes, which help schools to build a network and work in a European dimension); all of this may lead, probably not today but tomorrow, not everywhere but somewhere, to that participated research which is one of the goals of the seventh framework programme.
Aside from the environment, as previously shown, health is another key point emerging from the results. Probably the quantity of indirect medical information children receive is underestimated: while they listen to their parents, relatives and friends, while they watch the TV or browse magazines and newspapers. Maybe medicine should become a relevant subject at school. Not much as a study of the human body (which obviously is mandatory), not much or only as a "health education" which, as in the case of the environmental education, sometimes may only serve to ease our adults' conscience, rather than to impact on our children's life, but as a foundation for a medical knowledge that should make us aware users of medicine.

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