

Comment

Teachers' perception of the European scientists

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Introduction

A research¹ on the scientific imagery should have an opposite perspective to the one of a teacher at school; whereas the latter, the keeper of a knowledge, has the usual task of transferring and checking the knowledge in their students, a researcher has to record and describe their interior world relating to science – the information, but especially the images, the expectations, the emotions related to it:

The scientific culture has been studied and discussed more by analysing its gaps and deficits, rather than carrying out research on its contents. [...] Questions aimed at measuring the public understanding of science have shown how much and what people know, do not understand or cannot accept about science. Those are important data, but they tell half of the story: they allow for a subtractive (and pessimistic) analysis, in terms of what part of information is lost or degraded in the path between scientific production and the public. But they are of little help in understanding the methods and the ways people build their scientific expertise and their image of science and of a scientist.

On the contrary, studies on the public perception of science based on instruments such as focus groups, content analysis, open interviews allow for an additive approach: they contribute to raise the curtain on the context and the symbols we all superimpose, before and beyond the information we receive from the media or at school, in order to build our image of science and of a scientist.²

Yet teachers, for their professionalism and role, are special observers of the children's imagery. They meet pupils on a daily basis and debate their naïve conceptions, their beliefs and attitudes with them. Moreover, they highly contribute to build not only the knowledge, but also the beliefs and attitudes of students as concerns science, both directly, by teaching, and indirectly, by transferring, even involuntarily and in a non-planned way, their own conceptions and beliefs. We aimed at understanding what imagery related to science and the European dimension of science teachers have, in order to identify the images they carry when facing young students.

Hence, we asked ourselves some questions: what are the visions inspiring people teaching science? How do they imagine the work by a researcher? What do they believe is the role of science in society? Are they aware of the European dimension of research? Are they interested in the historical-scientific heritage of Europe? Are there recurrent elements in this imagery of theirs?

In order to answer all of these questions we drew a questionnaire that was partly inspired by the questionnaire used in Italy in the previous OCTS survey^{3,4}, so as to subsequently compare the data from both research projects; on the other hand, it was devised to include some of the questions from the SEDEC questionnaire submitted to the pupils, to verify the possible proximity or distance between the imagery of teachers and the one of pupils.

The scientist

The concept teachers have for a scientist may also be outlined by learning what scientists (past or present real ones) they encountered in their studies or through the mass media are the most famous ones among them – it was previously shown how much the figure of Einstein is invasive and decisive in this sense. In the questionnaire addressed to the teachers, as in the one for students, respondents were therefore asked

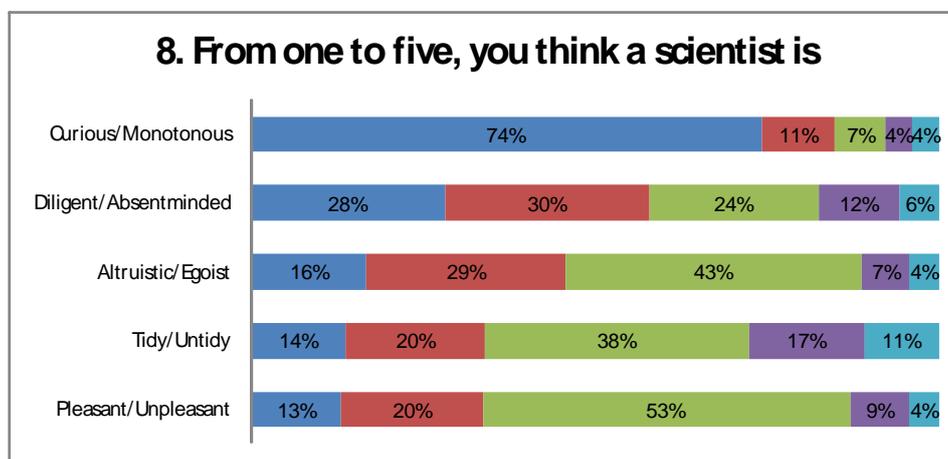
to “write the first three names of European scientists that occur to you”. In addition, the adjective “European” was meant to check whether a particular European dimension of research is revealed here through a list of key names, from the past or the present. Only 36 people (13%) did not write any name, and six mentioned only two names; the rest of the teachers wrote the three names, as requested. Approximately eighty scientists collected less than 4 mentions each, outlining a rich and varied scientific pantheon,⁵ whereas the majority of the mentions are spread on a group of 18 scientists.

Albert Einstein	121	Charles Darwin	18	Emil Racoviță	10	António Damásio	7
Marie Curie	63	Enrico Fermi	17	Ian Fleming	10	Henri Coandă	7
Louis Pasteur	47	Antonino Zichichi	15	Blaise Pasqual	9	Victor Babes	7
Rita Levi Montalcini	45	Renato Dulbecco	15	Georges Charpak	8	Antoine Lavoisier	6
Isaac Newton	42	Margherita Hack	14	Graham Bell	8	Alfred Nobel	5
Carlo Rubbia	39	Nikola Kopernik	13	Gregor Mendel	8	Ivan Pavlov	5
Galileo Galilei	25	Thomas Edison	12	Pierre et Marie Curie	8	James Watson	5

In the imagery of the teachers, science is still ruled by physicists, and Einstein is once again the undisputed leader, although the gap between first and second place is smaller than in the students’ list – and Marie Curie ranks second. The third position is occupied by Louis Pasteur, whereas Darwin, quite unexpectedly, is mentioned only by 18 teachers.

However, these data cannot be interpreted as European data, because a local factor has strongly affected the results. The Italian teachers, indeed, mentioned less scientists and with a much higher frequency if compared to their foreign colleagues. Therefore, as Italians constitute one third of the sample, seven Italian scientists are among the twelve most mentioned ones (the fourth place is occupied by Levi Montalcini, even though Italians are not aware she is so famous outside Italy).

Now that real scientists have been analysed, the image teachers have of a researcher will be dealt with in the following paragraphs. In order to outline this image, teachers were asked to attach some attributes to the scientists (hard-working, curious, etc.) and to give a value to them (i.e. we asked teachers to place a scientist on some Likert scales).



Some important features have emerged from it (cf. table 8). Reading the overall results of the scales, a scientist is more a positive person than a negative one: they are more pleasant than unpleasant, more curious than monotonous, more altruistic than egoist, more diligent than absent-minded. These are all terms associated with a positive connotation, especially when in contrast with their opposites.

Only one out of five scales sees a substantially balanced result: the one between tidy and untidy. These two attributes are apparently typical in the image of a scientist, so the sample is split in a substantially balanced way. This is totally consistent with what emerges from the analysis of the drawings (cf. chapter

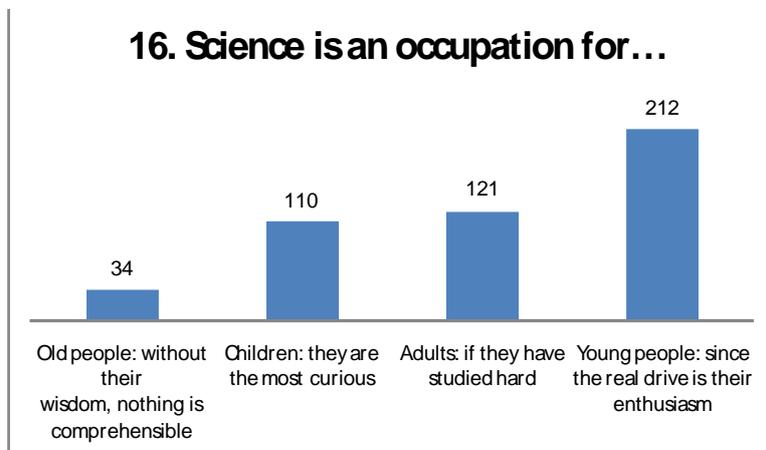
1): a scientist has a dual side, he can be a pedantic and spectacled hyperaccurate man, or conversely a crazy genius without even the time (nor the mood) to tidy up his clothes.

Curiosity is certainly the most important feature of his personality: three quarters of the sample believe that scientists are absolutely more curious than monotonous, and a further 10% see them as much more curious than monotonous.

It should be noted that the most patent features appear precisely in two qualities that regard the “professional” nature, as are curiosity and diligence. The more personal features, such as altruism and pleasantness, still receive some consensus, although a vaguer one.

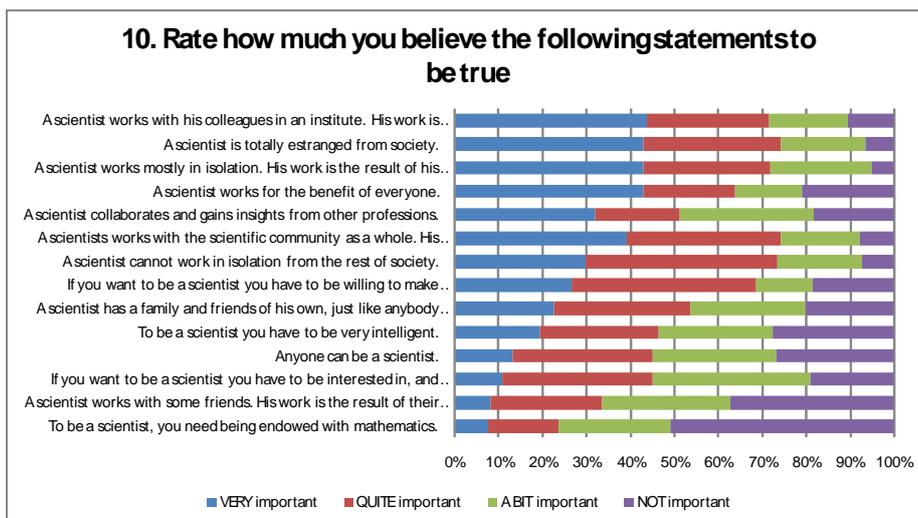
Another question in the form was about the most appropriate age to work on science. The question was indeed “Science is an occupation for...” and then the options were: children, young people, adults and old people. Childhood was associated to curiosity, young age to enthusiasm, adulthood to application and old age to wisdom. Teachers could choose up to two of them.

The results show that a scientist is first of all a young enthusiast. The wisdom coming from experience is not a relevant feature, whereas curiosity and application have a intermediate position (cf. figure 16, two options were possible).



A series of statements (about which teachers had to express their level of agreement: very much, quite, a bit, not at all) attempted at highlighting the social dimension of a scientist.

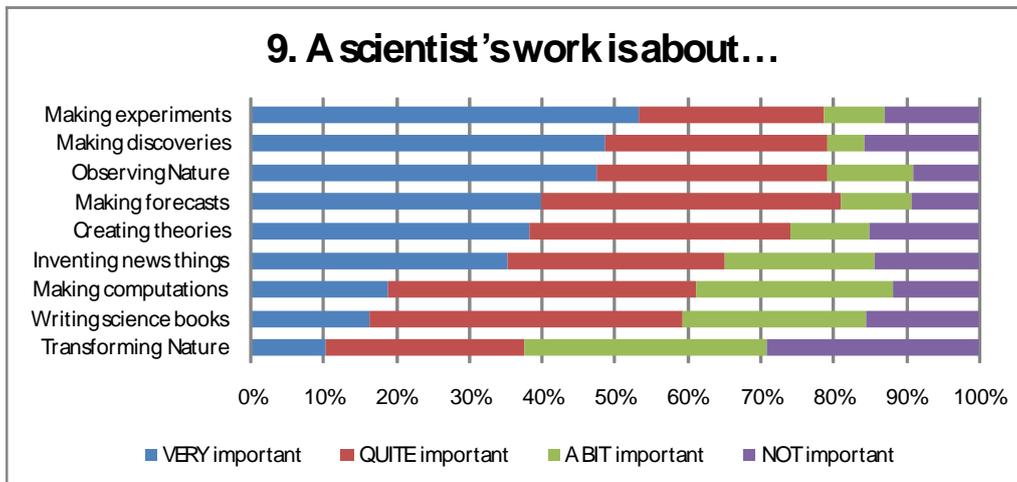
The results show that scientists still live in their ivory tower, “completely estranged from society”, work much on their own, but when they are not alone, they are with their colleagues. Yet, in the ivory tower, they still think about other people: indeed, they work for the common wellbeing.



One of the statements teachers said they do not agree very much with is, quite surprisingly, “to be a scientist, you need being endowed with mathematics” and less than half of them think that “to be a scientist you have to be very intelligent”; conversely, they do not believe that much that “anyone can be a scientist”; probably because many of them believe that “if you want to be a scientist, you have to be willing to make sacrifices”.

The work of a scientist

What is the work of a scientist about? The question no. 9 in the form required the respondents to classify in four grades, from very important to not important at all, some activities that altogether are part of the work by scientists, from “making forecasts” to “making discoveries”. The three most typical activities in the scientific research work are: making experiments, discoveries and observing nature (cf. figure no 9).



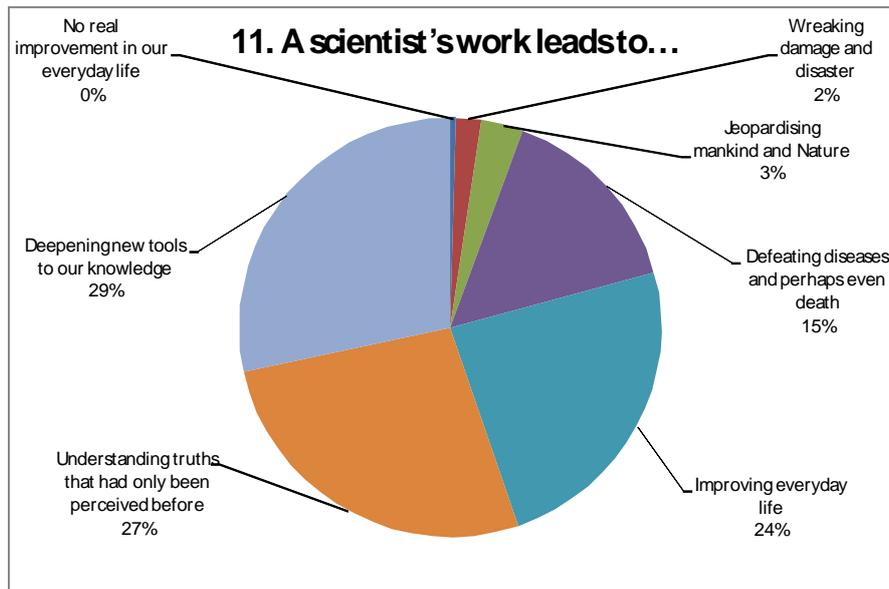
An interesting data regards “making forecasts”: if you consider the options “very important” and “quite important” altogether, according to teachers this activity is the most typical one in a scientist’s work; this data is in contrast to what children and pupils think, as they placed this option in the second-last position. Another visible difference between the choices made by adults and children regards “inventing new things”, which is slightly typical according to teachers, whereas it comes in second place, after “making discoveries”, in the children’s imagery – where, as previously mentioned, scientist, inventor and wizard are tightly interwoven figures.

Equally slightly important, according to adults, is “making computations”, maybe an unexpected result, even though it is consistent with the belief that to be a scientist it is not necessary to be good at mathematics.

Science, as an activity “transforming nature”, is quite common an image in mass media, frequently as regards controversial scientific issues: from the cloning of Dolly to the avian flu, from nuclear energy to GMOs. Then, in contrast with it, the transformation of nature is not, according to our sample, one of the typical activities of the work of a scientist. Actually it is the only option, among the given ones, that reaches less than half of the positive selections.

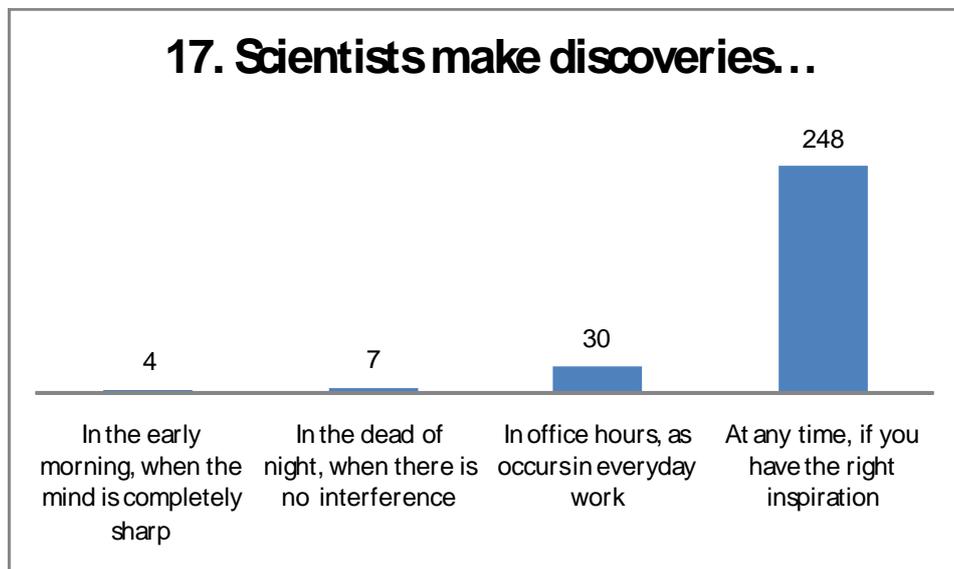
Well then, if it does not transform nature, what is the effect of the work by a scientist? A question in the form was about this issue; the teachers had to complete this sentence: “A scientist’s work leads to...” choosing among 7 possible endings (improving everyday life, defeating diseases and perhaps even death, etc.). They could choose up to three endings.

Three endings were most selected: a scientist’s work leads to the understanding of truths that had only been perceived before (27%), to the deepening of new tools to our knowledge (29%) and leads to an improvement in our everyday life (24%).



The following paragraph will deal specifically with the researcher's work, as it appears from the results of the questionnaire. A long series of sentences to be completed (still on the mentioned form) attempted at an analysis of the different aspects of the scientific research.

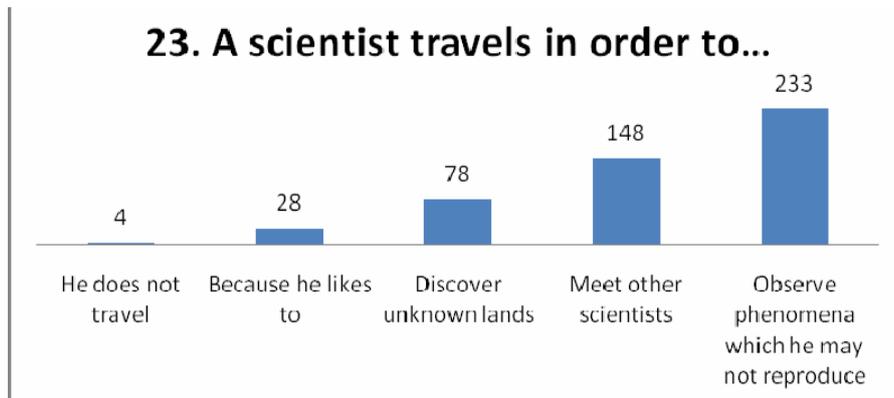
According to the majority of the teachers, discoveries can come at any time, provided that there is inspiration (figure 17; only a single selection was allowed). Conversely, ten per cent of the sample believe that results are achieved during the working time, i.e. there are office hours also to make discoveries.



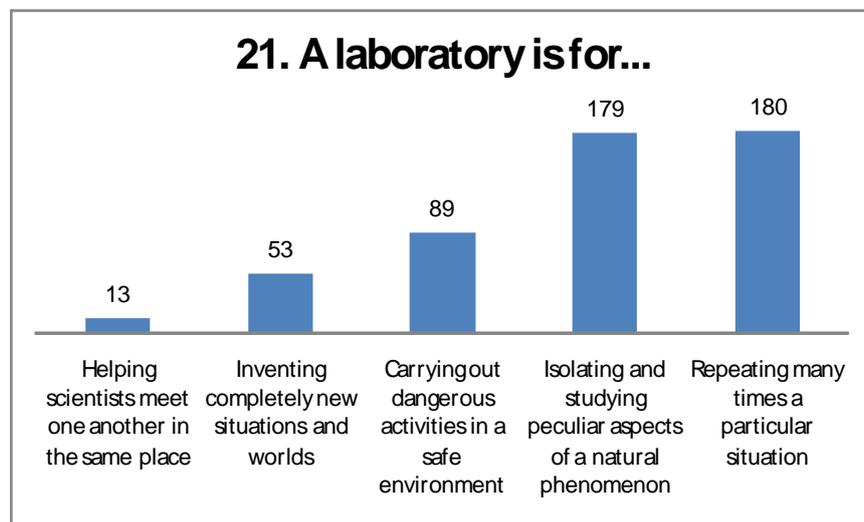
A contemporary scientist is a modern wanderer of knowledge, moving from laboratory to laboratory, changing institute, university, country, taking part in conventions, conferences held in remote and generally beautiful places. Are they seen like that also by those who do not know the world of research? And, most of all, what do the non-experts think about the reason behind a scientist's travels?

A scientist's travels are commonly justified by two reasons: first of all, to observe phenomena which he or she may not reproduce, and secondly to meet other scientists (figure 23; two options could be selected).

In addition, as selected by quite a significant number of teachers (28%), a scientist travels also because he or she likes to!

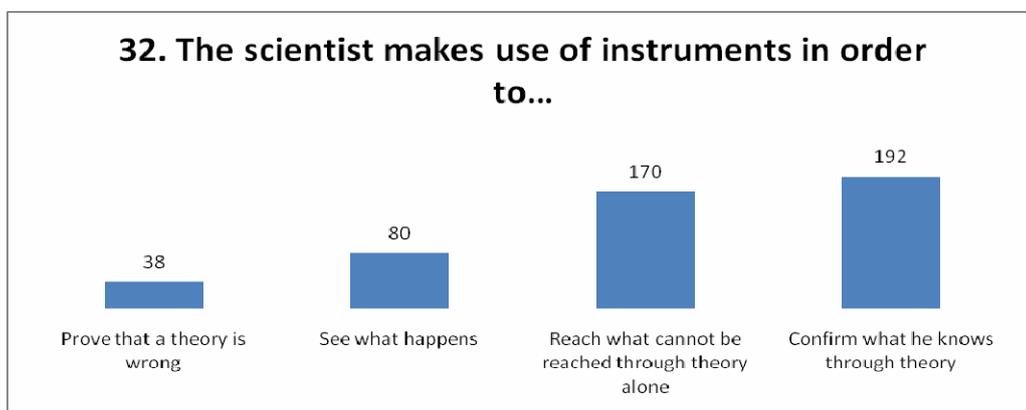


Unfortunately he or she does not travel all the time, and a considerable part of his or her activity is performed in the same place. In the imagery, the typical place for this activity is a laboratory that has primarily two functions (figure 21; two choices were allowed).



It enables to repeat a specific situation many times, and enables to isolate and study specific aspects of a natural event. It is the place for observation and verification, of precision and discipline, in one word, of repeatability, as a foundation of the scientific knowledge.

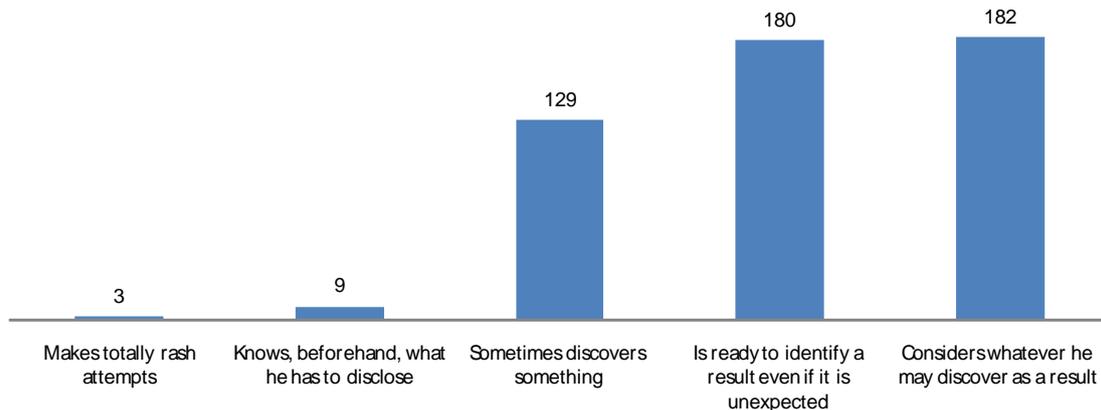
A laboratory contains instruments that, in their turn, are used especially to confirm what a scientist knows through theory (figure 32; two choices were allowed).



In the relation between experiment and theory, instruments, according to teachers, have more a positive function (*pars construens*), rather than a negative one (*pars destruens*).

Let's consider our imaginary scientist, in his laboratory, with his instruments. He works, observes, experiments. But when can he say he has achieved a result? All the time, according to many people! Just because everything he discovers is a result (figure 31; two options could be selected).

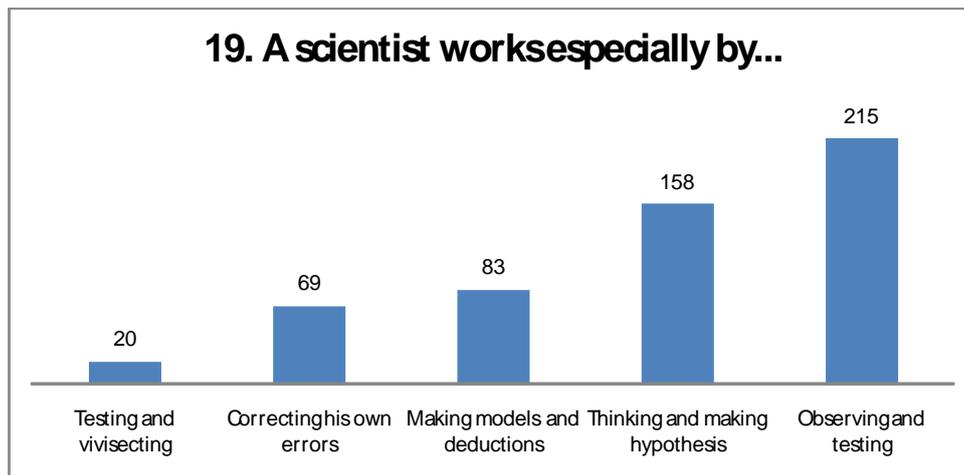
31. A scientist...



Alternatively, an equal number of people think that a scientist is moved by a special state of mind – Merton called it serendipity – that makes him prepared to recognise a result even though it was unexpected. In any case, teachers are aware that a scientist cannot know from the beginning what an experiment will reveal.

Finally, what are the actions, concrete or mental ones, that a scientist carry out? According to teachers, he primarily observes and verifies (figure 19; two options could be selected). Yet he also reflects and builds some hypothesis. Likewise, he sets up models and deductions. Everything is aimed at correcting the errors that he has committed.

19. A scientist works especially by...



Whereas errors are admissible, horrors are not, according to the teachers: vivisection, while existing in the children's imagery, is confined to a much more peripheral position than in the media, and probably than in the usual procedures of many research projects.

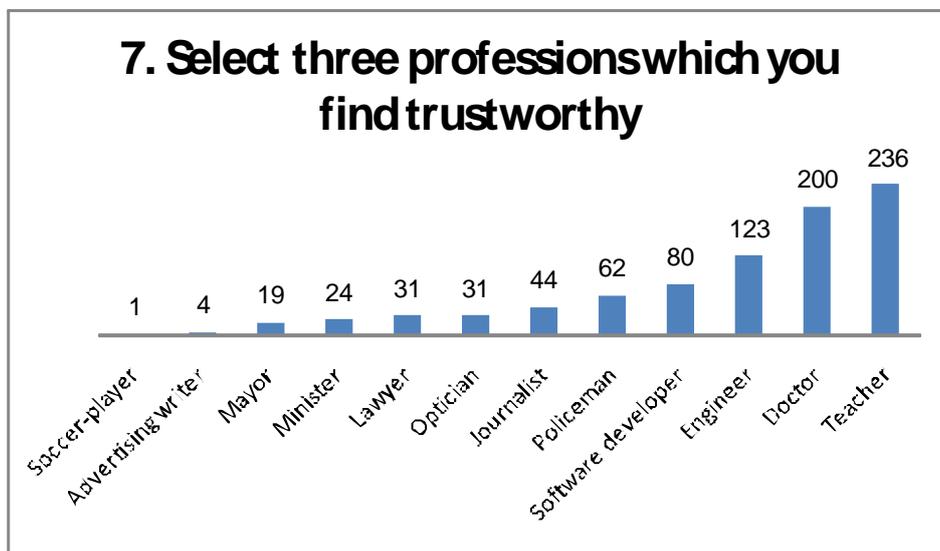
Trust

The final part of this article will deal with an analysis of the trust towards science and scientists.

The first question in this area was an attempt to assess the level of trust attached by the teachers to a series of jobs (figure 7; three choices were allowed). 85% of the sample consider the teacher as the most trustworthy figure of all. The three following positions seem to be linked to the different faces of science and technology (doctor, engineer and software developer).

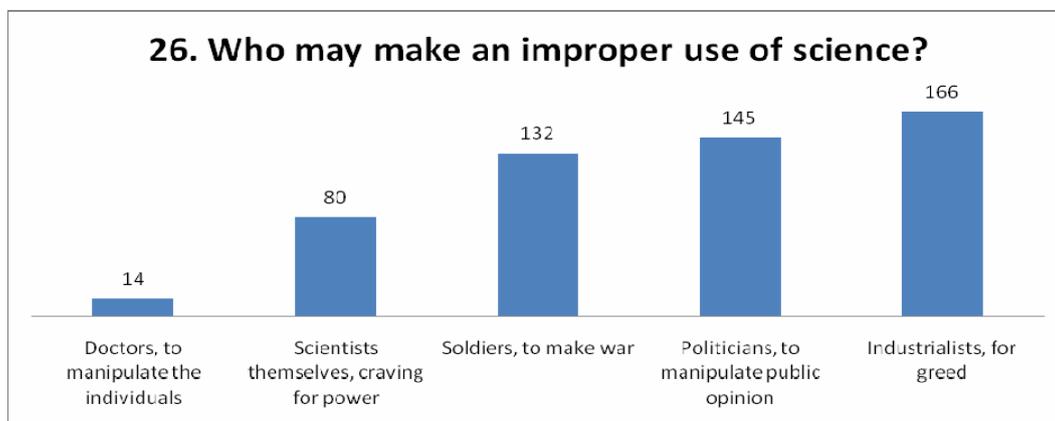
The less trustworthy figure is the soccer-player, quite obviously. The nature of the other professions ranking last in the chart is even more interesting: advertising writer, mayor and minister. Indeed, they are all characterised by a strong relation with decision-making and interest. The advertising writer's job is to influence individual decisions to guide purchase intentions, whereas mayor and minister are two decision-makers and, as politicians, are evidently biased.

Science is somehow placed at the opposite end of interest and politics; it is a place for a disinterested and expert knowledge, where trust can be rightfully put in.



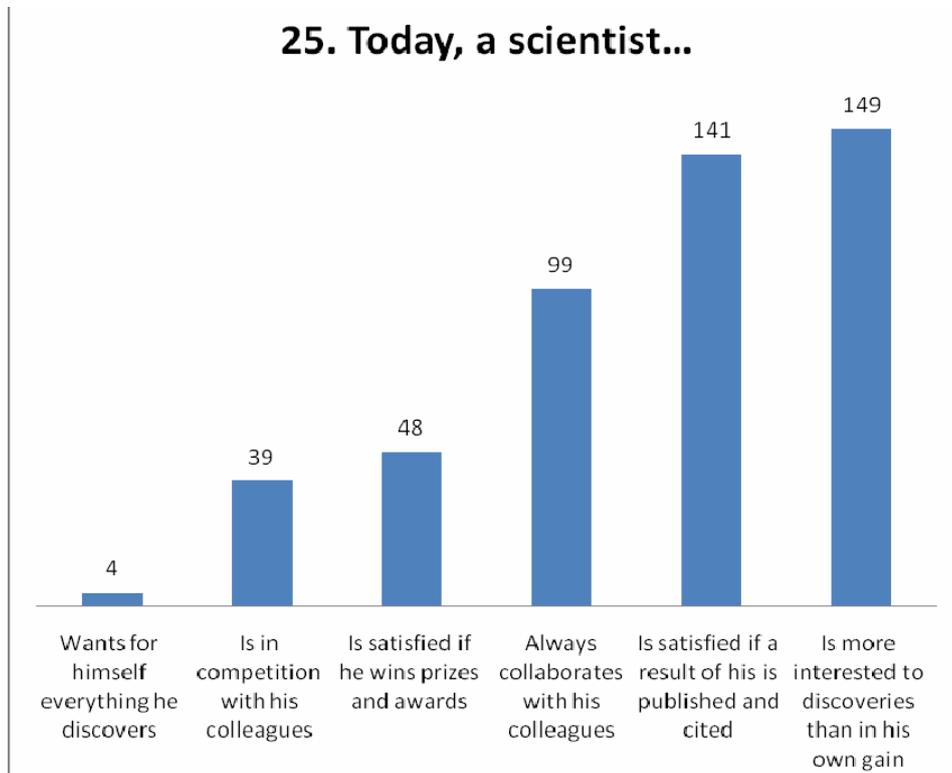
The results from answer no. 7 on the relation between trust and professions is confirmed by the results of question no. 26 (figure 26; two choices were allowed), which required the respondents to identify the people who may make an improper use of science.

Once again those who carry party interests (industrialists, politicians, soldiers) are the focus of the teachers' worries. Eighty teachers (i.e. a considerable 28%) consider that also scientists may use science for illegal and selfish purposes: the craving for power (once again the myth of Golem) may push them to use their knowledge in a wicked way.



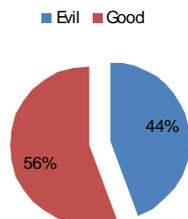
What are the interests scientists may carry, according to the teachers in our sample? The results (figure 25; two choices were allowed) once again outline a scientist showing no interests, whose spur is primarily his or her professional fulfilment.

These data depict once again a trustworthy figure.

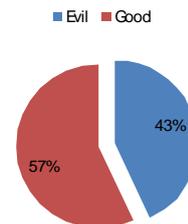


Finally, the general level will be now reconsidered and followed by an attempt at defining what the overall evaluation on the work of science is, in the past but also in the future (figure X and Y). Also the results of this last question delineate a view of science which is definitely positive, as well as equally positive expectations.

In the future, science will do more evil than good?



To date, science has done more evil than good?



These trust levels were not reached by the 5,000 Italian students that answered this question in 2003: indeed, whereas the result showed that the past action of science could be assessed as highly positive, the same did not apply to future expectations, which were positive in any case, even though to a lower degree. Older than the sample of students involved in this research, and less biased in favour of culture and knowledge than the SEDEC teachers, the Italian adolescents expressed a worry (probably on the basis of what the mass media show and convey) about a science more and more controlled by interest and/or in any case potentially dangerous for its growing abilities, which are not counterbalanced by a growth in social equality, peace and tolerance.

Notes and references

- ¹ This article exposes part of the results obtained in the Sedec (Science Education for the Development of the European Citizenship) project (<http://albert.osu.cz/oukip/knybel/comenius/>).
- ² Y. Castelfranchi, *For a paleontology of the scientific imaginary*, JCOM0203(2003)C02 <<http://jcom.sissa.it/archive/02/03/C020302>>
- ³ F. Manzoli, Y. Castelfranchi, D. Gouthier and I. Cannata, *Children's perceptions of science and scientists*, in The 9th International Conference on Public Communication of Science and Technology, Seul (2006).
- ⁴ D. Gouthier, I. Cannata, Y. Castelfranchi and F. Manzoli, *The perception of science and scientists in the young public*, in The 9th International Conference on Public Communication of Science and Technology, Seul, 2006
- ⁵ 2-4 mentions: Egas Moniz, Guglielmo Marconi, Leonardo da Vinci, Niels Bohr, Otto Wichterle, Stephen Hawking, Umberto Veronesi, Giulio Natta, Hanri Coandă, Karol Linneusz, Konrad Lorenz, Wolszczan, Alessandro Volta, Ann McLaren, Aristotele, Clara Pinto Correia, Dmitri Mendeleev, Francis Crick, Gerard Genette, Gustav Hertz, Haroun Tazieff, Hubert Reeves, Jacques Monod, Jean Piaget, Lumiere brothers, Max Planck, René Descartes, Sigmund Freud, Wolniewicz
1 mention: Absolon, Alexander Fleming, André-Marie Ampere, Antonin Holý, Archimede, Augustin Cauchy, Aurel Vlaicu, Axel Kahn, Camillo Golgi, Carlo Linneo, Charles Coulomb, Conrad Roentgen, Paul Crutzen, Giuseppe Di Bella, Ernest Rutherford, Erwin Schroedinger, Ferdinand de Saussure, Fischer Hans, Francesco Salamini, Franco Brezzi, George Palade, Grigore Moisil, Helghe Koch, Henri Poincaré, Jan Purkyně, Jan Werich, Jaroslav Heyrovský, Jean-Pierre Haigneré, Johannes Gutenberg, Joseph Jacquard, Jozef Łukaszewicz, Karl Marx, Krzysztof Pilch, Joseph-Louis Lagrange, Léon Schwartzenberg, Lise Meitner, Lobo Antunes, Ludwig Boltzmann, Marco Bersanelli, Michel de Montaigne, Michel Rocard, Michel Rolle, Neil Armstrong, Nicolae Paulescu, Parhon Constantin, Piergiorgio Odifreddi, Pitagora, Platone, Scipione Bobbio, Silvio Garattini, Tommaso Poggio, Vasile Parvan, Voskovec, Watson and Crick, Werner Heisenberg, Wróblewski, Young