Trust and worries
Science and scientists in the answers of European teachers

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In this article we will present and discuss the data coming form the part of the SEDEC survey aimed at understanding what image teachers have of science and scientists.

The teachers, by virtue of their professional competence and role, are special observers of 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 building 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. For those reasons 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 who teach science? How do they imagine the work done 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 drafted a questionnaire that was partly inspired by the questionnaire used in Italy in the previous OCTS survey[1,2], 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 that of pupils.

Implementation of the questionnaire and sample

After having tested the questionnaire on a small group of teachers, the form was posted online in a private web page, and the partners of the project invited groups of known teachers to fill it in. They were enabled to answer the questionnaire autonomously, any time and any place they deemed suitable.

The goal to be achieved was a sample, comprising a minimum number of 50 teachers in each of the 6 countries involved in the project. It was nearly accomplished (279 completed

questionnaires were collected), yet organisational problems in each of the countries hindered the formation of a totally balanced and numerically satisfactory sample.

Like the survey concerning pupils, also this part of the research does not claim to be statistically significant for the European context; its goal is rather to identify trends and thematic areas, to be possibly further analysed or to be used as suggestions to later devise the educational activities of the project.

As far as the participant countries are involved (Czech Republic, France, Italy, Poland, Portugal, Romania), the distribution is quite balanced; however, Italy is overrepresented, whereas the Czech Republic is underrepresented (fig. 1).

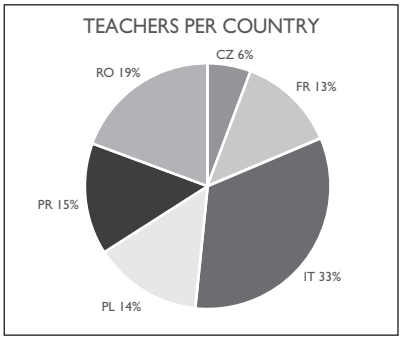


Figure 1. *Teachers per country*

The teachers of the sample are from primary and secondary schools, although if the majority works in primary schools (fig. 2).

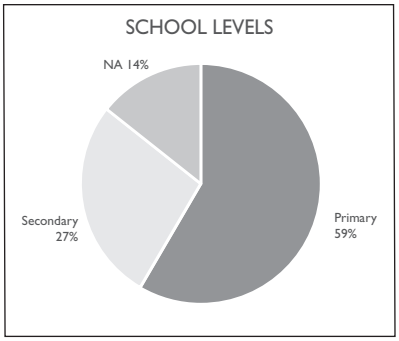


Figure 2. *Teachers per school levels*

As regards the gender, quite not surprisingly 84% of the teachers are women. This data is relatively constant in all of the countries involved (fig. 3).

In relation to the age distribution, two thirds of the teachers are quite young, though not very (fig. 4). It is to be noted that this data varies very much in the different countries: in Italy, young teachers are totally missing, whereas there are a lot of teachers over 46. The opposite happens in the Czech Republic and Romania, where young teachers constitute the majority of the sample. Finally, Portugal and France substantially follow the general trends, although the former has a number of teachers above the average in the 26-35 age group and the latter has it in the 36-45 age group.

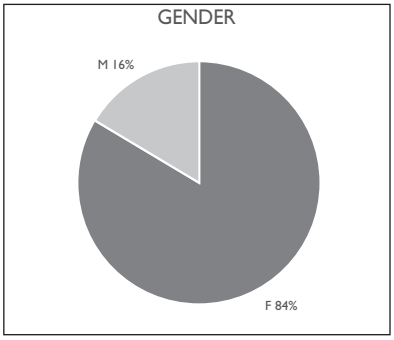


Figure3. *Teachers per gender*

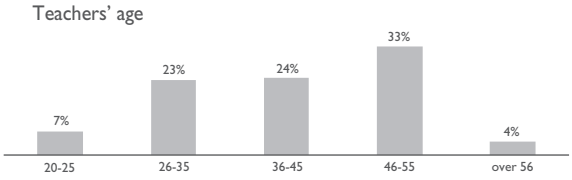


Figure 4. *Age of the teachers*

The scientist

In the questionnaire addressed to teachers, as in the one for students, respondents were first of all asked to "write the first three names of European scientists that occur to you" (table 1). The adjective "European" was meant to check whether a particular European dimension of research has emerged. 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 registered less than 4 occurrances each, outlining a rich and varied scientific pantheon,[3] whereas the majority of the occurrances are spread over 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

Table 1. *Scientists mentioned by the teachers at least four times (number of occurrences)*

In the imagery of the teachers Einstein is once again the undisputed leader, although the gap between first and second place is smaller then in the students' list. Marie Curie ranks second, and 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 he Nobel Price Rita Levi Montalcini, even though Italians are not aware she is so famous outside Italy).

In order to outline what image teachers have of a scientist, they 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) (fig. 5).

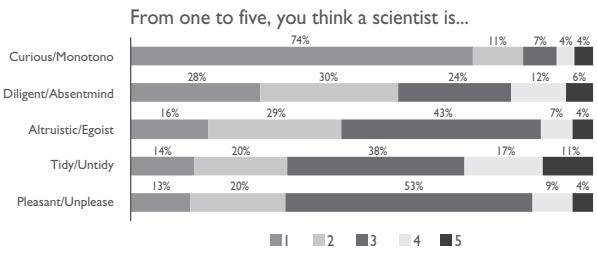


Figure 5. *Characteristics defining a scientist*

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, two attributes who are apparently both typical in the image of a scientist. This is totally consistent with what emerges from the analysis of the drawings: a scientist has a dual side, he can be a pedantic and spectacled hyper-accurate man or, conversely, a crazy genius with no time (nor inclination) to tidy up his clothes.

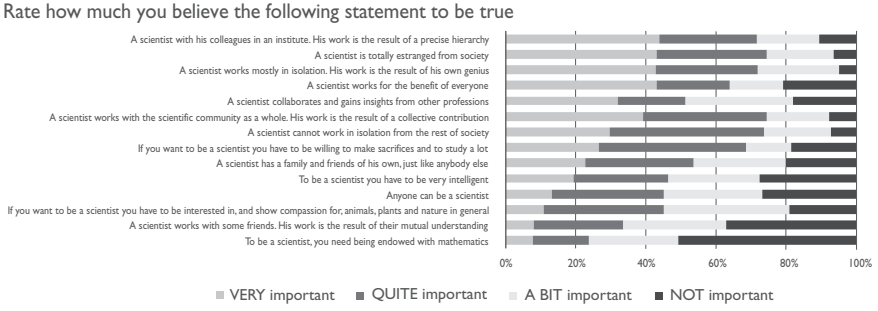
Curiosity is certainly the most important feature of his personality: three quarters of the sample believe that scientists are absolutely more curious than monotonous, and a further 10% see them as much more curious than monotonous.

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 more vaguely .

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 very 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 well-being (fig. 6).

Figure 6. *The social dimension* of a scientist



One of the statements teachers said they do not agree with very much is, quite surprisingly, "to be a scientist, you need being gifted in 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? Question n. 9 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 (fig. 7).

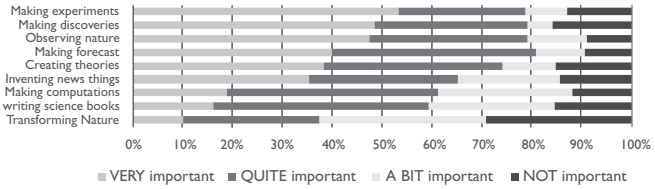


Figure 7. *The work of a scientist*

Interesting data emerge regarding "making forecasts": if you consider the options "very important" and "quite important" together, according to teachers this activity is the most typical 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 second after "making discoveries" in children – for whom, as previously mentioned, scientist, inventor and wizard are tightly interwoven figures.

Again, according to adults "making computations" is slightly important, 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.

A rather common image of science in mass media is that of science as an activity that "transforms nature", particularly as regards controversial scientific issues: from the cloning of Dolly to avian flu, from nuclear energy to GMOs. However, on the contrary, 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 responses.

As it does not transform nature, what is then 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 dis-

eases and perhaps even death, etc.). They could choose up to three endings.

Three endings were the 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%) (fig. 8).

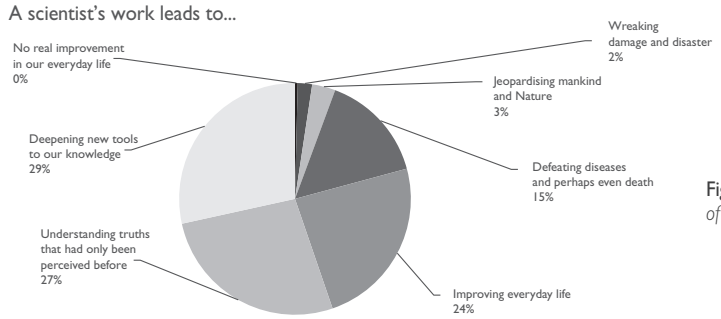


Figure 8. *The results of scientists' work*

A long series of sentences to be completed attempted then at an analysis of the different aspects of scientific research.

According to the majority of the teachers, discoveries can come at any time, provided that there is inspiration. Conversely, ten per cent of the sample believes that results are achieved when actually at work, i.e. discoveries occur during office hours.

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 be unable to reproduce, and secondly to meet other scientists. In addition, as selected by quite a significant number of teachers (28%), a scientist travels also because he or she likes to do so!

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. The typical place for this activity is a laboratory that has primarily two functions (fig. 9; two choices were allowed).

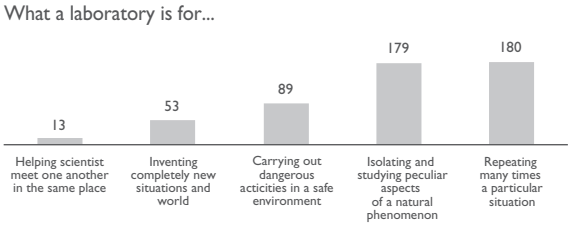


Figure 9. *Why work in a laboratory*

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

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).

According to teachers, the scientist primarily observes and verifies (fig. 10; 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.

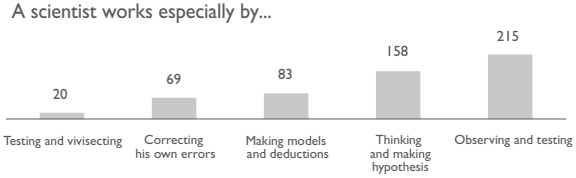


Figure 10. *What a scientist does*

While errors are admissible, according to the teachers horrors are not,: vivisection, while existing in the children's imagery, is confined to a much more peripheral position compared to the media, and probably compared to the ordinary 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 (fig. 11; three choices were allowed). 85% of the sample considers 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

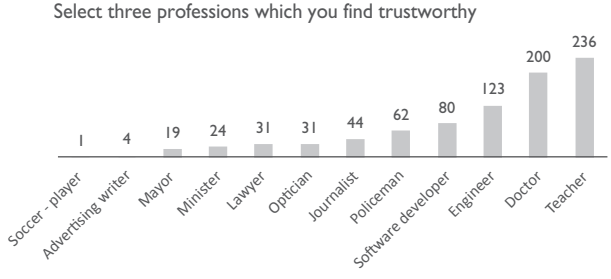


Figure 11. *Trust and professions.*

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 in order 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 the spectrum compared with politics; it is a place for disinterested and expert knowledge, in which trust can be rightfully placed.

The results in answer n. 7 on the relation between trust and professions is confirmed by the results of question n. 26 (fig. 12; 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.

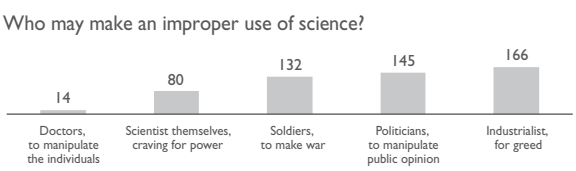


Figure 12. *The misuses of science*

What are the interests scientists may carry, according to the teachers in our sample? The results (fig. 13; two choices were allowed) once again outline a scientist showing no interests, driven primarily by his or her professional fulfilment. These data depict once again a trustworthy figure.

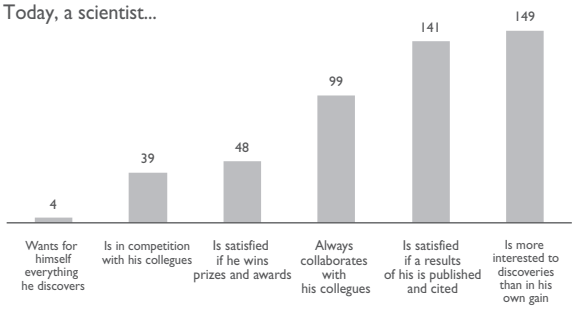


Figure 13. *Scientists's interests*

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 (fig. 14). Also the results of this last question outline a view of science which is definitely positive, as well as equally positive expectations.

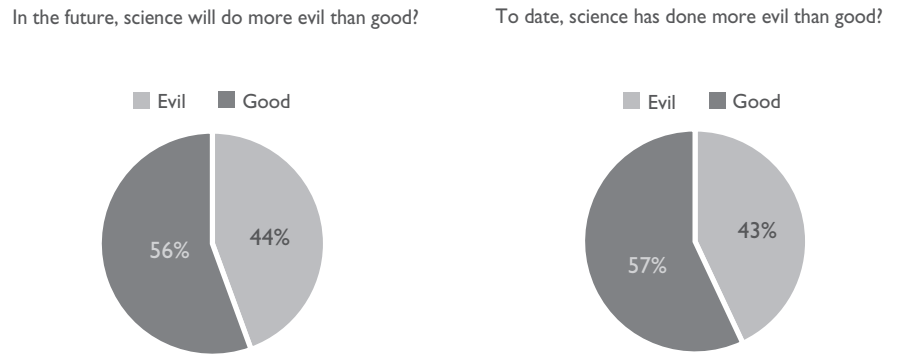


Figure 14. *Science and the future*

These levels of trust 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, Italian adolescents expressed a concern (probably on the grounds of what mass media show and convey) about a science more and more controlled by interest and/or in any case potentially dangerous for its development, which are not counterbalanced by a growth in social equality, peace and tolerance.

Notes and references

1 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).

2 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

3 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, Antonín 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