CHAPTER 3

How to undo young people's stereotypes about scientists and science

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3.1 Making Science "Cool"

Stereotypes about scientists are not completely negative and under certain circumstances they may well be considered positive: who does not like to be smart, able to solve crimes with formulas and equations, as in the TV series *Numbers*, or famous for discoveries that have solved the biggest problems of humankind? The issue is that these stereotypes imply positive qualities that are so extremely positive that they set the bar unrealistically high and can inhibit young people's aspirations to be part of the group. "I am not a genius, I cannot be a researcher", "I am not clever

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enough to be good at science" or "Science is too difficult for a girl like me" are some of the phrases that exemplify how extremely positive qualities can leave ordinary people feeling apart.

Inaccurate stereotypes exist around the STEM sector and its role in society: on the one hand STEM is not perceived, by both boys and girls, as a field where there is passion for discovery, but rather as a dry, fact-based matter ; on the other hand, girls are not encouraged to the same extent as boys to embark on a scientific career, in particular in STEM.

The widely held view that scientists are smart, combined with the commonly held stereotype that they are exceptional individuals, may prevent many young people from considering careers in science as a life opportunity. The popular idea that science careers are only for the very clever few is strengthened by the limited awareness young people have of the broad range of possibilities (both in and beyond science) that scientific careers can lead to. Families also lack the necessary information to encourage their children towards science and technology. In a study on young people's science aspirations, ASPIRES (2013, p.30) concluded that "*children from families possessing medium or high science capital are more likely to aspire to science and STEM related careers*". Conversely, because the majority of children do not come from families with medium or high science capital, they are not expected to show any interest or to be excited about science, innovation and technology as a future career opportunity – and yet Great Britain is one of the best places in the world to do science.

Since 2001 the European Commission has highlighted the lack of interest of young Europeans in science and technology related careers (European Commission 2001). In the Eurobarometer survey on young people's aspirations (see European Commission 2007a), unattractive and difficult science education in schools was

identified as the main reason for this. Since then, across Europe, many actions have been taken. According to Valente (2015), under the Sixth Framework Programme almost €20 million have been spent on a number of initiatives aimed at increasing the proportion of students in the STEM sector. Under the Seventh Framework Programme the amount of money spent by the European Commission on this aim increased, to more than €90 million. The initiatives included measures aimed at increasing students' interest in STEM at school, engaging students in activities that raised awareness of STEM jobs and organizing STEM fairs or European science weeks for families and children (Valente 2015).

Despite the European Commission's efforts, the results are not yet satisfactory. As observed by Deloitte (2014), in 2012, while a steady and considerable growth in the share of 30- to 34-year-olds who have successfully completed university or other tertiary-level education took place in the EU, only 23 per cent of all EU-28 graduates held STEM qualifications (a slight increase from 22 per cent in 2007). Cultural stereotypes that deter young people from being fascinated by science and becoming scientists seem hard to remove.

The European Commission gave special attention to the aim of attracting girls into scientific research, and into STEM in particular. According to Eurostat (2015), within the EU-28 close to three fifths of all graduates in 2015 were women, while male graduates accounted for three fifths of the total number of graduates for the science, mathematics and computing fields, and close to three quarters of the total for engineering, manufacturing and construction-related fields. In the EU-27 women remain largely under-represented (at 32 per cent of the workforce) in scientific research and innovation (Eurostat 2015).

Women and girls shun science, technology, engineering, and mathematics, and their presence is low at all levels of the STEM

career pipeline, from the interest to study a STEM discipline to having a career in a STEM field once adult. As observed by Correll (2004), cultural stereotypes and the attitudes of women themselves make the challenge of having more female scientists tougher. There are many societal beliefs about how women do not have strong mathematical ability and about how men make better engineers and scientists (Correll 2004). Girls are not encouraged by families to embark on a science career, because such a career is considered too hard for girls; peers look down on them as weird for taking that interest.

The OECD has noted that young people generally have a positive view of science and technology, but that the image of STEM as a profession is largely negative (OECD 2008). Positive contacts with science and technology at an early age can have a long-lasting impact, while negative experiences at school, due to uninteresting content or poor teaching, are often very detrimental to future choices.

In the last decade, given the challenge of increasing the number of young people entering scientific careers, numerous initiatives at the national and European levels have been taken to inspire young people about science and make careers in science and technology attractive for them. The initiatives varied both in content and in aims: some were focused on the challenges facing education systems and the need to modernize pedagogical methods; others on enhancing the professional profile of teachers. A number of initiatives were launched to promote partnerships between schools, universities and industry and projects to improve female participation in STEM courses and careers. This series of activities is still yielding weak results and is not aimed at undoing the stereotypes affecting the image of scientists and the content of science.

In order to undo stereotypes that prevent young people from embarking on scientific careers, special attention should be given to two sets of initiatives carried out at the EU level: the awards to young students aiming to give visibility to the creativity and imagination of younger generations, and the organization of fairs aiming to arouse interest in science within younger age groups and to encourage them to embark on research careers.

Since 1989 the European Commission has organized a contest called the European Union Contest for Young Scientists (EUCYS) with the goal of promoting cooperation and exchange among young scientists and guiding them towards a future career in science and technology. Every year, approximately 200 students attending European high schools enter the competition in the hope of winning awards. The awards are of monetary kind: in 2015 the awards were €7,000 for the first-prize winning teams, and €5,000 and €3,500 for the second- and third-placed teams respectively.

Awards are also given at the national level, including at The Big Bang Fair in the UK, "I giovani e le scienze" ("Youth and Science") in Italy, "Unge Forskere" ("Young Scientists") in Denmark and "Jugend forscht" ("Youth research") in Germany. In such events, small teams of students (usually at secondary level) are invited to research and develop STEM projects of their own choice over several months, and then to display the results of their work at a dedicated fair.

The preparation of the projects is often done through after-school science clubs or in the students' personal time. As observed by Joyce and Dzoga (2011), the projects are chiefly tackled outside school, so those students with home environments that encourage STEM (e.g. if parents are working in scientific careers or have interests in science) can be disproportionally advantaged

compared to students whose family awareness of STEM is not as conducive to understanding the value of engaging with extracurricular activities. In some cases, the projects remain at the planning stage, without the production of a functioning prototype.

Though improvements can be made to better integrate such initiatives into normal class activities, there is no doubt that the existence of student competitions helps generate interest in the sciences and increases the understanding of the relevance of science to real-world issues among all students. Last but not least, it facilitates the overcoming of stereotypes concerning science careers and encourages young people to embark on research-related studies and careers.

Alongside the contests, many science fairs where small teams of students, usually at secondary level, also research and develop STEM projects of their own choice take place around Europe. The fairs are linked to national or local student contests and EUCYS then links to national science fairs, thus creating a pyramid of merit and talent among European young people. The fairs target both students in school with their teachers and parents who visit the fair with their children. They are an opportunity for bright students to showcase their abilities, creativity and imagination and might be a motivational tool to engage those students who are lagging behind in STEM disciplines.

3.2 Inv-Factor: A Contest For Young Inventors

Who does not know *The X Factor*, the television music competition whose title refers to the indefinable "something" that makes for star quality? Millions of European boys and girls like the competition and watch TV to follow other boys and girls dancing, singing and explaining that they have a dream: to become a star

in the field of music. The message one can draw from that TV show is "If you really want to be a singer or a TV star, you can do it". Obviously reality is different, and a lot of talent is needed, together with a lot of work that has to be put into nurturing that talent. Nevertheless, the TV programme is brilliantly made; it is addictive and compelling.

We thought that something similar might be done in the field of science with the aim of dismantling the stereotypes concerning scientists and science careers. The messages would have to be "If you really want to be a scientist, you can do it" and "Science is the most fantastic work you can do". Within the framework of the *Light* project, we organized a contest to look for the special "something" that makes for scientist material. The contest was called INV-Factor, because we were looking for the capacity to be an inventor and gave out awards for inventiveness and imagination.

In our opinion two aspects of existing contests and student fairs should be improved: the awards should not be monetary, and only school or classroom teams should be eligible for the contest. Regarding the first aspect, it should be noted that the main reward for scientists – as for creative people in general – is emotion, not financial incentives: it is the feeling of making progress every day towards a meaningful goal. As shown by Pink (2009), studies carried out over 40 years back up the idea that, for most tasks, you cannot incentivize people to perform better, create and innovate with money – this is one of the most robust findings from social science, but also the most ignored.

Regarding the second point, we know that one of the best parts of the job of scientists is getting to work with other scientists and sharing ideas with other people. The best ideas no longer come from solitary researchers, and it is clear that all of us together are smarter than each one of us individually. In spite of this reality,

when boys or girls think about scientists, the picture that pops into their heads is that of a solitary scientist, an isolated genius, working on some world-changing solution to a problem. For centuries, the Western model of science has been simple: we relied on geniuses; our most revolutionary breakthroughs have typically emerged from individuals, working by themselves. This is not true anymore, but the false picture has remained in people's minds, becoming a deep-rooted stereotype.

In order to undo the stereotypes concerning scientists held by young people, we have to change this picture and let them experience that being a scientist means being part of a team, working together to figure out something new. Young students do teamwork at school, and we thus decided to create a contest for schools. Teams who intended to participate in our competition had to present the products of the work they had done with their classmates and teachers during school time.

As monetary rewards are not appropriate to encourage young students to embark on scientific careers, we thought that the best award for the winners of INV-Factor was to let the young inventors participate in a great science communication event together with adult scientists.

The segregation of young people's creativity in purposively organized fairs puts young participants on a secondary level in respect to adult researchers and conveys the following message: "You are too young to invent something really interesting". There are many examples demonstrating how wrong this stereotypical idea is. Think of Mark Zuckerberg, the creator of Facebook, or just look around on the internet: you will be amazed by the number of teens who spent their time and energy to create new things to make a better world for everyone. There is no doubt that, when it comes to inventing, it is not age, but being a visionary, that

counts – and this is exactly the quality we were looking for with the INV-Factor contest.

The contest was organized in three steps. We started by announcing it on a dedicated website and on the CNR website. The contest's rules were published online; the media were informed by press releases from the CNR and the Representation of the European Commission in Italy.

The rules of the contest specify the following details and requirements:

- the contest aims at stimulating and enhancing the scientific creativity of 15- to 19-year-old students;
- we want functioning prototypes of inventions, and not just brilliant ideas;
- the students should have acquired at school the scientific knowledge and competencies needed to conceive and realize the inventions;
- the contest is primarily aimed at vocational and technological high schools, though all high schools are eligible;
- classroom or school teams are eligible for the contest; isolated inventors are not excluded, but they should be supported and mentored by a teacher from their school (to be honest, we never had proposals coming from individual geniuses!);
- in the application for the contest a representative of the classroom team should be identified to facilitate contacts between the organizers and the students;
- inventorship and ownership of the invention go to all team members.

When the teams applied to participate in INV-Factor they had to very briefly describe their idea and how they intended to realize it,

the school where they studied and the team composition. A committee of noted researchers, mainly – though not exclusively – from the CNR, made a first selection. Candidates could be asked directly to give additional information in order to better illustrate their idea. The teams that were considered eligible for INV-Factor were then asked to realize a functioning prototype of their invention, to be presented at the final contest.

Four months later, the second step was launched and the selected teams were asked to send home videos, photos and drawings of the prototypes of their inventions, as well as presentation slides and a text of maximum 1,000 characters describing their work. On the basis of the material presented, the panel of five INV-Factor judges, which consisted of three CNR research directors, one representative of the Representation of the European Commission in Italy and one representative of the small and medium-sized enterprises' association, selected ten inventions.

The final step was the core of the contest. We organized something similar to the *X Factor* live performances of competitors in front of judges and other contestants. We are convinced that every team should be aware of what the other teams did and of why the panel of judges arrived to the final decision, awarding one team instead of the others.

All the inventions were exhibited on the premises of the Representation of the European Commission in Italy in Rome. The panel of judges went from one invention to the other, asked questions, checked the functioning of the prototypes and asked for technical information. The media were also invited and a large number of journalists from newspapers, TV channels and radio stations, both local and national, were present.

The panel of experts evaluated the inventions on the basis of three criteria listed in the regulations: novelty from a technological

point of view; feasibility of the invention; and social impact of the invention. The preparation and competency of the teams was also tested. In a conference room, each team had exactly five minutes to give a slideshow presentation about their invention in front of judges, the media and other competitors. The idea is that if you know what you have done and why, you should be able to describe it in five minutes and convince the judges that your invention is the best. A well balanced mixture of communication skills, competency and determination was thus evaluated.

It is to be noted that special attention was given to the sex composition of the teams and a special award was given to female inventors. Women are generally less competitive than men, and this could affect their desire to participate in a competition where boys are the majority (in Italian vocational schools, boys are the majority). We encouraged female participation, ensured gender equal opportunities in winning the award and dedicated a special prize to girls.

Regarding the inventions, we were amazed by the fact that the teens were so attentive to recent news, facts and stories. For example, a student team invented a device to save lives, after learning how many babies die from heat-related deaths after being trapped inside vehicles because the drivers forgot the children were there; another team invented an alcohol-measuring device combined with an ignition interlock that prevents vehicles from starting if the driver has alcohol on his or her breath. Young people were also willing to solve problems for people with disabilities: a team invented a device that can guide blind people, only requiring them to wear a simple special hat; another team created a special wheelchair that can be guided by voice. Mobile phones are another attractive topic; among others, let us mention an invention to charge mobile phones through the energy generated by

walking, the inventors of which – all girls – were knighted by the President of the Italian Republic.

As mentioned above, the award for the winners of the contest was to participate in *Light*. The boys and girls were thrilled by the opportunity to be side by side with adult scientists, and many of them expressed the intention to choose a scientific faculty for further study and the desire to follow a scientific career. Exploring career options is an important step on the road to adulthood. Science is considered to be difficult, and the general opinion is that you need to have talent for science (a special gift), otherwise you will not be successful. We do hope that INV-Factor has contributed to change this image.

3.3 Suggestions and Recommendations

Scientists are imagined by young students as isolated geniuses or people who must have special talents to do their job. In the minds of teens, science allows little space for factors such as intuition, imagination and creativity and deals more with hard facts. At the time of career choice this stereotyped view of science and scientists could have an important influence on discouraging young people (and girls in particular) from embarking on scientific careers. The European Commission has launched various initiatives to attract young Europeans towards the sciences and science careers. Among other initiatives, we think that contests concerning inventions made by teens are valuable tools for overcoming the "science is too difficult for me" stereotype. The following are our suggestions to undo young people's stereotypes about scientists:

- one of the best tools to break down the stereotype that science is for the very clever and talented few is to showcase the creativity and inventiveness of the teens;
- contests aimed at stimulating and enhancing the scientific creativity of 15- to 19-year-old students are a great opportunity to show the potential of younger generations and to overcome the "I am not a genius, I cannot be a scientist" stereotype;
- girls should be encouraged to participate in the contest and equal opportunities should be ensured;
- the importance of the collaborative nature of scientific and technological work should be stressed and the contests should be addressed to classroom or school teams;
- awards of monetary nature should be avoided;
- the segregation of young inventors in dedicated fairs is in conflict with the idea that creativity is not related to age.