D2.1
Final protocol of tested methods to transform a performance-based activity into a PERSEIA

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THE BIG VAN THEORY

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PERFORM
Participatory Engagement with Scientific and Technological Research through Performance

Contents

SUMMARY

This deliverable corresponds to task 2.1 “Inclusion of the “human dimension” of science and the values embedded in RRI in performance-based activities” aiming to identify and include key education and communication tools in drama-based activities that address young people’s interests in Science, Technology, Engineering and Mathematics (STEM) and the values of the Responsible Research and Innovation (RRI) approach. For this purpose, a series of exploratory workshops were performed in selected secondary schools of Spain, France and United Kingdom (UK) to reflect on RRI topics and STEM education concerns and expectations with 467 participant students. Out of these reflections, an integrated methodological protocol based on specific guidelines was developed to adapt performance-based activities delivered by three science communication partners (stand-up comedy by Big Van (TBVT) in Spain, clown based on improvisational theatre by TRACES in France and busking theatre by Science Made Simple (SMS) in UK) to new PERformance-based Science Education and Innovative Activities (PERSEIAs). Resulting PERSEIAs were delivered in 35 secondary schools in the three countries, reaching 2490 students. These PERSEIAs were assessed to determine whether they were a useful tool to increase STEM interest and RRI values among secondary school students. As the final outcome of this research process, this report includes in section 7 an integrated methodological protocol of tested methods to transform drama-based activities about science into PERSEIAs.

1. INTRODUCTION

A considerable percentage of young people in Europe is not interested in STEM careers. The international study on "Social Perception of Science" conducted by the BBVA Foundation (2012) reported that the percentage of people who admitted having in mind to study a scientific career varied from 25.2% in UK to 16.4% en Spain or 18.8% in France. In the last decades numerous authors have alerted of the decline of the scientific vocations in the European context (EC, 2001; Convert & Gugenheim, 2005; Rocard, Csermely, Jorde, Lenzen, Walwerg, & Hemmo, 2007; OECD, 2008). Jenkins and Nelson (2005) have used the paradox “important, but not for me” to explain the fact that, in practice, fewer and fewer students opt for scientific careers.

The PERFORM consortium aims to investigate the effects of the use of innovative science education methods based on performing arts in fostering young peoples’ motivations and engagement with STEM in secondary schools in France, Spain and UK. PERFORM thus addresses the challenge of engaging young people in STEM, a challenge in Europe in order to avoid loss of scientific talent and to ensure future innovation capability, excellence and competitiveness.

On one hand, the notion that research and innovation should address major societal challenges has become salient in contemporary research and innovation (R&I) policy. EU officially introduced this notion in its so-called “rationale report” (EC, 2008), and soon became incorporated in official EU policy discourse, as shown by the Lund declaration (July 2009). It finally has become one of three main pillars of the Horizon 2020 programme. As many authors have noticed (Gassler, Polt, & Rammer, 2008; Mowery, et al., 2010; Weber & Rohracher, 2012) the emergence of the term 'societal challenges' and its incorporation to R&I policies reveal new goals and priorities, new approaches to collaboration and to governance, but also the emergence of new actors and instruments in R&I practices. Following this insight, PERFORM project takes societal challenges as one of the pivoting axis of its pedagogical approach.

On the other hand, Responsible Research and Innovation (RRI) is a wide umbrella connecting different aspects of the relationship between R&I and society: public engagement, open access, gender equality, science education, ethics, and governance. PERFORM connects with RRI as for being a research project into science education tackling with gender, ethics and public engagement issues. In order to get a broader approach, PERFORM considers RRI issues, and specifically gender equality, as a key variable to take into account when designing the science education methods based on performing arts.

Moreover, PERFORM deals with gender issues, since numerous studies in the European Union and other countries, including Canada and the United States, have reported for decades the persistence in the segregation around the choice of scientific careers, and especially STEM degrees and occupations (European Commission, 2012; Beede et al., 2011; Hango, 2013). Particularly in the physical sciences and engineering, women remain under-represented (Smith 2010a, 2010b) as well as in mathematics (Huguet & Régner, 2009). For example, the 'She Figures' report published in 2016, which contains the most recent available European data on the involvement of women in science, reveals that men are more than twice more likely than women to choose engineering, manufacturing and construction, whereas women are twice as likely to pursue an education degree.

Studies completed in the last three decades have shown greater stability in the way that girls and boys have different interests and attitudes toward studying science and different perceptions of scientists and science careers (Keeves and Kotte, 1992; Gail Jones, Howe, & Rua 2000; DeWitt, Archer & Osborne, 2014). It is also remarkable the role that extracurricular experiences play at the European context. Even though the situation might have changed, at the beginning of this century male students reported to be more engaged with a variety of activities and tools related to STEM disciplines such as "batteries, electric toys, fuses, microscopes, and pulleys" while female students reported more experiences with bread-making, knitting, sewing, and planting seeds" (Gail Jones et al., 2000: 180). All this has contributed to a biased gendered relationship in relation to science

from very early ages (Keeves & Kotte, 1992; Alexander, Johnson, & Kelley, 2012).

However, it is important to note the lack of connection between discourse and practice that has been detected when dealing with issues related to gender equality. Literature points out that secondary school students have learnt and assimilated a politically correct discourse linked to social desirability and hegemonic positions that is not always in accordance with the final behaviours or performances (Bourdieu & Passeron, 1977; Bourdieu, 2001). This makes especially difficult to detect misogynist attitudes in young people, since most of them do not identify gender barriers in relation to their attitudes to and participation in science (Ofsted, 2011). For this reason, PERFORM will tackle gender issues in science when dealing with the humanisation of STEM disciplines.

Furthermore, the European Commission has a clear vision about the important role of ethics as regards science. In this line, secondary school students' ethical concerns falling into the sacralisation of nature as well as the artificial dualism between nature and culture is typical of the western culture (Haila, 2000; Jasanoff, 2011). As most of their concerns fall into animal and environmental issues, private life and health issues, PERFORM project addresses students' perception on ethical standards on these topics in the research process.

To summarise, in its aim to humanize science and to engage secondary school students through performing arts, the PERFORM project will take into consideration gender, STEM jobs and careers, societal challenges and ethical issues. For doing so, PERFORM has developed an integrated methodological protocol of tested-methods to transform performance-based activities into PERformance-based Science Education and Innovative Activities (PERSEIA) for fostering young people's interest in science.

2. OBJECTIVES

The general objective of this document is **to identify and include key education and communication tools in drama-based activities that address the human dimension of science, young people's interest in STEM and the RRI values.** PERSEIAs are defined as an applied drama-based educational approach drawing upon the values of RRI to promote science learning and engagement among secondary school students. Drama has participatory, dialogic and dialectic qualities that foster the integration of both rational and emotional dimensions within the learning process, providing a rich source of individual and collective experimentation and exploration (Nicholson, 2005). This general objective is subdivided in the following operative specific objectives:

1. To carry out a series of exploratory workshops in selected secondary schools in Spain, France and UK to foster students' reflection about their concerns, needs and expectations in STEM education, RRI values as well as their interests on relevant scientific topics related to current EU societal challenges.
2. Based on 1, to design a series of specific guidelines to adapt existing performance-based activities to PERSEIAs.
3. To deliver these newly created PERSEIAs to secondary school students in Spain, France and UK.
4. To implement a sound evaluation methodology to assess how these PERSEIAs have improved the interest of students towards STEM, as well as their ethical and gender concerns.
5. To generate a Final protocol of tested methods to transform a performance-based activity into a PERSEIA.

3. EXPLORATORY WORKSHOPS: METHODS AND CONCLUSIONS

To identify and include key education and communication tools in drama-based activities that address the human dimension of science, young people's interests in STEM and the RRI values, PERFORM designed and conducted six exploratory workshops with secondary school students from UK, France and Spain. The schools were chosen from medium and low socio-economic contexts, as was stated in the Document of Action (DoA).

In this section we describe the methodology applied and the conclusions obtained for the six exploratory workshops conducted. Data collected during the exploratory workshops will be available in the public repository Zenodo, and the data analysis is shown in Annex 1.

3.1 Exploratory Workshops Design and Analysis Methodology

As stated in the introduction, the PERFORM approach tackles issues related to RRI and societal challenges. For this reason, the project consortium designed the following six exploratory workshops (EW):

- EW1 - STEM market: The role of entrepreneurial and multidisciplinary research careers in labour market
- EW2 - Stereo-science-types: Science-related stereotypes
- EW3 - Life recreation: Ethical issues in scientific research
- EW4 - Our priorities for the World: Relevant scientific topics related to current EU societal challenges
- EW5 - Science and me: Two-way dialogue between scientists and the society
- EW6 - Guess who: Gender inequality and girl's barriers in STEM

The detailed description of the activities carried out in these EWs is available in Section 7. It was decided to use exploratory workshops as a research method instead of focus groups initially planned in the DoA due to the impossibility of

splitting a classroom of 25-30 secondary school students into groups of 8-10 students in any of the selected schools in the three case studies, which is a condition for conducting focus groups. In contrast, a workshop format, although presents its limits in terms of discussion, allowed for the exploration of the topics we needed for elaborating the protocol.

In order to collect information from secondary school students' EWs, 6 Data Collection Protocols were designed (see Section 7). Data were gathered in two different ways according to the nature of each workshop:

- EW1 - STEM market, EW3 - Life recreation, EW4 - Our priorities for the World, and EW6 - Guess who: Data gathered through information written on post-its by the students and sorted by them according their preferences about the different topics.

- EW2 - Stereo-science-types, and EW5 - Science and me: Data gathered through participant observation during role playing games performed by students who recreated different scenarios in which students were involved. For example, in EW 2 students were asked to design and delivery short theatre sketches representing situations like "a scientist with her/his couple in an everyday situation".

In both cases, written notes were taken on the students' comments and discussion about these topics by the facilitators during the workshops. Facilitators also took notes on non-verbal information such as the students' mood, as well as complementary data such as their reception of the activity and any other relevant factors that could affect the implementation of the EWs. These inputs were thus useful to identify contextual particularities in the development of the activity.

A total of 27 EW were carried out in selected schools of each country

between March and May 2016, with a participation of 467 secondary-school students aged between 13 and 15 years (see figure 3.1 and table 3.1).

Figure 3.1. Exploratory workshop on Gender issues. Santa Eulàlia School, Terrassa, Barcelona, Spain.

Distribution by gender and socio-economic level is reported in figure 3.2. Informed consents to participate in the activities were obtained from participant schools and parental informed consents were obtained in the case of students.

Table 3.1 Number of participants per country.

Spain	United Kingdom	France	Total
181	142	144	467

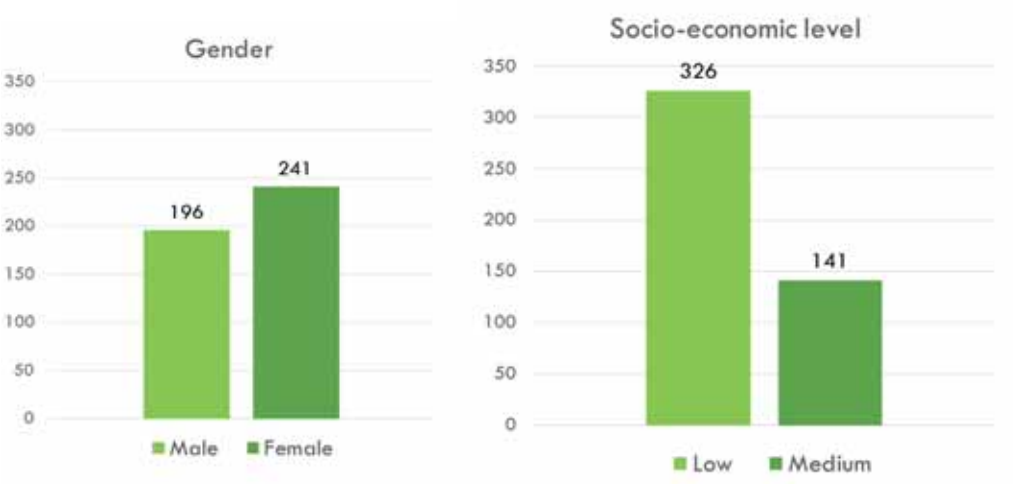

Figure 3.2: Distribution by gender and socio-economic level

3.2 EW1- STEM market: The role of entrepreneurial and multidisciplinary research careers in labour market

A total of 70 students participated in this EW aiming to identify those professions perceived by students as the most attractive considering the consensus list of "best jobs ever" they ranked. Discussions were held in small groups (4-5 members) in which students drew up their own lists of professions. Finally, the facilitator counted the mentions of each small group and elaborated a final list.

Also, students identified those features related with their ideal jobs. We measured the weight of each of them by the number of mentions they received during students' interventions in the EW in relation to the total number of mentions about the different features identified in each EW. For further details see Annex 1.

After data analysis, we observed a positive image in the way students characterize the two professions mentioned (i.e., engineers and doctors) which were strictly related to STEM careers. They saw engineers as "fun", "enjoyable" or "creative" people (UK group) while doctors were perceived as having a special ability for "teamwork", "quick-thinking" and "help people" (UK and France groups).

Paying attention to local particularities some differences in the answers of students were noted. Firstly, participant students in the UK were those who had

most mentions of jobs related to science in their list of "best jobs ever", while their Spanish counterparts only mentioned architecture as STEM career in the strict sense of the term –although in a broader sense the pilot profession can be considered to involve the use of scientific techniques -.

Secondly, professional motivations also differ in their nature. In UK, participant students appreciated the social utility of their choice and were closer to intrinsic motivations. Meanwhile, in the French schools, students also valued jobs related to support and social recognition but they differed of their UK counterparts in including professions related to the army and the police services under this tag. Incentives related to extrinsic motivations (i.e. "money") and low effort level (i.e. "no need long studies") were also important for some French students. Finally, the Spanish sample was fully identified with motivations that clearly fall within the extrinsic extreme and, like the French one, whose students valued that their "best job ever" did not involve a great sacrifice (related with the category "no need long studies").

In general, our data showed a moderate relationship between STEM careers and aspirational jobs, although their intensity was irregular along the case studies. **To reinforce positive attitudes of secondary school students towards STEM careers, and according to these results, some recommendations can be extracted: (i) PERSEIAs should highlight that science and STEM jobs are everywhere, (ii) some of the features that students consider positive (travelling, helping other, etc.) can be found with STEM jobs, and (iii) some well-considered jobs are actually STEM jobs.**

3.3 EW2- Stereo-science-types: Science-related stereotypes

A total of 81 students participated in this EW, which aim was to explore the stereotypes that young people associate to scientists. To this end facilitators assigned to each small group of students -of 4 or 5 people- one situation related to professional and personal life of scientists, and they had to deliver, in front of all

the class, their short representations. After that, a discussion on the represented stereotypes was done with all the class assisted by facilitators. For further details see Annex 1.

As an outcome of the activity it was possible to picture an image of a scientist based in those statements more commonly recorded among participant students. They identified scientists as brilliant, curious, compulsive people, with undermined social abilities that make very difficult for them to engage with others, either in public or personal contexts.

Students also considered scientists to be hard working people who are motivated more by their thirst for knowledge than by economic or material rewards. Participants stated that scientific careers are a long-term goal, which requires high levels of commitment and dedication (see figure 3.2).

Figure3.2. Exploratory workshop on stereotypes. Fairfield High school, Bristol, UK.

Additionally, students shared the impression that most research work is developed with very limited material and financial resources, as this student from Spain mentioned:

> *"In laboratories there is a boss in charge, and they usually have very little money to research and pay their workers".*

In order to understand some of the conclusions it is important to consider the EW facilitators' remarks. Among the most interesting observations made in the three case studies was the fact that most of the stereotypes which emerged during the different role plays were strongly influenced by TV fiction. In particular, by American sitcom 'The Big Bang Theory', premiered on CBS on September 24th, 2007.

It was also noted that participants did feel comfortable playing as scientists regardless their gender, and there were no specific gender references when describing a scientist during role plays, although there were some scientific professions, such as chemist, that were strongly masculinized in some contexts. Finally, the lack of references to what have been called the 'Frankenstein Myth' that presents scientist as mad evil people should be mentioned.

A general remark that can be extracted of EW2 and should be taken into account when designing new PERSEIAs was to reinforce positive stereotypes such as "external recognition and self-confidence" or "the ability to solve problems through their imagination", as well as to break the negative ones such as scientists being "nerd", "socially awkward", "intransigent", "locked in their own world" and "without time for anything else than their own work".

3.4 EW3- Life recreation: Ethical issues in scientific research

A total of 74 students participated in this EW. In this EW we identified those ethical implications involved in scientific discoveries through the confection of two lists. In one of them students ranked some innovations provided by facilitators from "doable" to "impossible", while in a second list they reorganized the items from "unacceptable" to "desirable". For further details of the activity see section 7 and for data analysis see Annex 1.

This EW aimed to make students realize, verbalize and discuss about their own ethical feelings on science and innovations. Across the categorization of several scientific applications in the axis "doable-impossible" and "unacceptable-desirable" the students showed their own preoccupations about the eventual enforcement of these realistic ("make a bacteria that can produce energy") and fantastic ("know at birth how you will die") items.

With regard to the rejection attitudes towards some of the items, the majority argument was revolving around their concern about the possibility of scientists to "play God", breaking the supposed natural balance. In their imaginary an association between "natural" and "good or appropriate" order existed. Accordingly, students only allowed scientific intervention when it comes to fix the deviations that human beings has caused in the natural course. Examples of this view were provided by one student from UK and another from Spain:

> *"We must revive extinct species only if the extinction was humans' fault. In other way would be unethical"*

> *"If it is to re-create extinct species killed by humans (...) then it is a very good thing"*

In this EW explicit religious arguments were barely shown, although this type of argument based on a mystification of nature could be considered as a subtle

reminiscence. Other strong arguments within rejection positions to some of these applications were related to a concern about the unintended consequences of inventions, especially the loss of employment, as this student from Spain mentioned:

> *"Create humans without diseases are the most important, but would leave the doctors unemployed"*

Also they used some arguments, probably influenced by their cinematographic culture, consisting in the fear of some of the artificial creations that can rebel against humans, as this student from France:

> *"Make robots could remove the work from humans and they could take over the world"*

Sensitivity to interference in the private life of individuals as a way of predetermination was also present in their arguments, but in a minority of the students. In particular, a student from UK was worried about the items referred to choosing some characteristics of babies before their birth:

> *"Being good at school should be a decision taken by the child, not by the parents"*

Animal and environmental awareness in eventual scientific experiments and public participation awareness in relation to the process of scientific decision-making were among the students' shared worries, as this student from UK mentioned:

> *"It is compulsory to bear in mind citizens' opinion"*

The underlying notion of utility associated with science in their speeches showed some peculiarities of the local contexts. In the case of Spain, for example, the usefulness of knowledge was not perceived if it did not involve humans, while in France and the UK workshops, knowledge represented a value in itself, further on that it was useful for the human well-being.

Also, UK students were able to notice many nuances in discussions and they gave much importance to their assessment of ethical considerations (as it usually said, "devil is in the details") showing more maturity in their responses than French and Spanish students. This is perhaps the reason why participant students in the UK had more difficulties to reach a consensus on ethical issues in this EW. The end point of most discussions was the need to appeal to an "expert", a figure to which they attach great relevance when it comes to assess decisions related to science. Finally, there were also differences around problematic issues related to scientific discoveries in each national context, shown in table 3.8.

Table 3.8: Controversial issues per country.

Controversial topics of UK students
Bring back to life a person who has been under cryogenic process
Creating a custom sized dog
Create a child who will always be top of the class

Controversial topics of French students
Chose the sex of a child
Bringing back to life someone who has been under cryogenic process
Cloning a human being

Controversial topics of Spanish students
Recreate an extinct species
Build a living being from inert matter
Cloning a human being

In general, all participant students had well identified some recent advances of science; so that in the ranking from possible to impossible applications most of the groups gave answers coherent with reality. However, in the French case study some

topics like “clone a human being” or “knowing at birth how you will die” reached marks that put them in the place of the “possible” applications.

In conclusion, from this EW some general recommendations were deduced to build new PERSEIAs: (i) they should highlight that scientists follow ethical rules, and (ii) that research is not conducted to generate useful knowledge only for humans' benefit.

3.5 EW4- Our priorities for the World: Relevant scientific topics related to current EU societal challenges

A total of 54 students participated in this EW. Its objective was to identify students' choice of most pressing societal challenges and compare if such proposals coincide with the societal challenges identified by the European Union. Facilitators set up a fiction scenario in which students were asked to decide the big challenges that the world is facing in three levels: neighbourhood / city, country, and European level. Then facilitators assigned each student’s proposal to a specific European societal challenge of the H2020 Programme (i.e., “Health, demographic change and wellbeing”, “Food security”, “Sustainable agriculture and the bio economy”, “Secure, clean and efficient energy”, ”Smart, green and integrated transport”, “Climate action and environment” “Inclusive, innovative and reflective societies”, “Secure societies, freedom and security”) and students discussed about them. The specific protocol for this workshop can be seen in section 7, and the data analysis can be consulted in Annex 1.

Although health was a priority to students, it was possible to identify significant differences between the challenges receiving the highest number of proposals in each case study. While in the Spanish case study climate actions were almost as important as health issues for students, for French participants security was a key priority (see figure 3.3), more important even than health. In the case of UK, students perceived environment and security as equally relevant although the number of proposals received by these two issues was considerably lower than the number of post-its dedicated to health.

Figure 3.3. Exploratory workshop on societal challenges. School Grange aux Belles, Paris, France.

Finally, it was noted on facilitators' remarks that some challenges were not properly understood by the students, such as the concept of reflective societies. They found the item to be too ambiguous or difficult to translate into recognisable daily situations.

On the second hand, facilitators pointed out that those proposals made by students from low socio-economic neighbourhoods in the three case studies were very specific and mostly focused on solving common social problems perceived as daily situations. Meanwhile students from medium socio-economic backgrounds formulated wider proposals tending to cope globally with the problems associated to a particular challenge.

As for this EW, lessons learnt show that further PERSEIAs should address those societal challenges considered of interest by students as a hook, taking into account the local particularities discovered. For this reason, EU societal challenges should be approached using specific and contextualized examples.

3.6 EW5- Science and me: Two-way dialogue between scientists and the society

A total of 51 students participated in this EW. The aim of this EW was to analyse how students currently interact with science and scientists and how they would like to do it. In order to reach this goal, facilitators asked students to prepare a programme on a specific media (YouTube channel, TV channel, radio program, newspaper) about science and society. Each group delivered their programmes tothe rest of the class. The specific protocol for this workshop can be seen in section 7, and the data analysis can be consulted in Annex 1.

The separate analysis of this particular EW results was especially interesting due to the important differences observed between participant students in the different countries. The level of interest varies from very low levels in the Spanish case study, where a facilitator noted that half of the participants declared not being interested at all in what scientist do; to higher levels in the UK case study, where students stated to be very interested in researchers' work, considering the important impacts of their work in society.

When participant students were asked about their main sources of information regarding science, Internet and specially Wikipedia appeared in all three countries as popular sources, but while for Spanish students those were the only cited sources, in French and UK case studies students also included their teachers as a more reliable source. In addition French students highlighted the influence of scientific museums as scientific sources, while for UK students' media, particularly the BBC channel and scientific books were also important and reliable scientific information sources (see Annex 1).

Regarding their personal experience with scientists, Spanish students stated not having any particular daily contact with researchers, as they did not identify their science teachers as scientists, while for French and UK students the image of their science teachers being scientists was very clear. When citing relevant scientists all three groups of students mentioned both historical figures, such as Isaac Newton or Albert Einstein or celebrity scientists from the media, such as

Stephen Hawking or Eduard Punset in Spain and Brian Cox in the UK.

Finally all three groups claimed to be highly motivated for participating in science but when interacting with a researcher, Spanish students were more interested in knowing about their current job, while for students in both French and UK case studies personal information about scientists' daily lives and work was also important. Participant students in UK showed higher levels of interest in improving their scientific literacy by consulting with scientists.

Out of these results some tips can be extracted to use in future PERSEIAs. It is important to highlight to students that their STEM teachers are relevant sources of scientific information. Besides, PERSEIAs should include the name of relevant scientists.

3.7 EW6- Guess who: Gender inequality and girls' barriers in STEM

A total of 92 students participated in this EW. This EW identified students' perceptions about those features associated to STEM jobs and promote discussion about whether those features can best suite a man, a woman or neither (gender neutral). With this purpose students were organised into groups of 3 or 4 members and each group worked with STEM jobs from the following list: inventor, veterinarian, chemist, astronomer, and geologist. They wrote down on different post-its 5 things that characterise the people doing those jobs. Later their notes were discussed to assign a gender (masculine, feminine or neutral) to each adjective. Finally, the total percentage of features assigned to each gender was weighted based on the number of total adjectives handled in the EWs (see figure 3.4). The percentage of the features of each gender associated with each profession was pondered by the total of the adjectives received in a particular career. The specific protocol for this workshop can be seen in section 7, and the data analysis can be consulted in Annex 1.

Figure 3.4. Exploratory workshop on gender issues. Santa Eulàlia School, Terrassa, Barcelona, Spain.

Overall, most of the adjectives related to scientific professions were gender neutral. If we pay attention to particular professions, astronomy appeared strongly related with "feminine" attributes and the most masculinized ones were geologist and inventor. Veterinary and chemist were seen by the students as the most gender neutral careers.

The association between scientific professions and gender stereotypes did not seem to be very strong. The category of “gender neutral” adjectives was the most relevant if we pay attention to the whole set of answers given in the three case studies. For this reason, **the tips that can be extracted from this EW for further PERSEIAs are to highlight that STEM** jobs are **not gendered, paying special attention to girls and chemistry. Also, to show female and male scientists as role models.**

4. SPECIFIC GUIDELINES TO GENERATE PERSEIAs

4.1 Guidelines emerged from EW

A series of guidelines and recommendations have been drawn out of the conclusions of the EW's. These guidelines were fine-tuned considering the conclusions of D4.1 (D4.1 "Research report: methodological aspects of science education assessment"-p. 50), local particularities, and the kind of performing disciplines used in PERFORM project (scientific monologues in Spain, clown in France and science busking in UK). The guidelines were collected in the table 4.1 and were shared with TBVT, TRACES and SMS to adapt a performance-based activity into a PERSEIA.

Table 4.1: Guidelines to Generate PERSEIAs

G1: STEM JOBS
To highlight that science and STEM-Jobs are everywhere: ✓ An excavation, an electoral survey, an architectural studio, a plane, an engineering company, the zoo, a football team, in science communication events
To highlight STEM-Jobs features that young people consider positive: ✓ Travelling, helping others, having a flexible schedule, involving hands-on activities, reducing injustice
To highlight that some well-considered jobs are actually STEM-Jobs: ✓ Architect, airline pilot. Take into account local particularities.
G2: SCIENTIFIC STEREOTYPES
To highlight positive stereotypes of science and scientists: ✓ External recognition, knowledge motivation, long term goal. "Knowledge gives you power: the more you know, fewer lies you will believe" ✓ Imaginative, self-confident
To break negative stereotypes of scientists: ✓ Freaky, nerd, boring, bad couple or parent, social rejection, unable for

social relations, always «ON» and in their own world
G3: ETHICS IN RESEARCH
To highlight that scientists do not play to be God, as all new discoveries are under ethical control: ✓ GMO, Artificial Intelligence/Robots, medical advances (cloning, genetic modifications in humans)
To highlight that research is not only conducted to generate useful knowledge from the human being interest point of view. Ethical standards promote research on basic science as: ✓ Improve the environmental quality ✓ Generate basic knowledge to improve nature understanding ✓ Ensure animal rights
G4: EU SOCIETAL CHALLENGES
To use the EU Societal Challenges that students have considered of interest as a hook: ✓ Health, demographic change and wellbeing ✓ Climate action, and environment ✓ Secure societies, freedom and security
To take into account the local particularities: ✓ UK: Health, demographic change and wellbeing ✓ France: Secure societies, freedom and security ✓ Spain: Climate action, and environment
G5: DIALOGUE SCIENCE AND SOCIETY
To highlight the figure of teachers as scientists and as trustable scientific information source.
To include examples of current scientists: ✓ For example: Lynn Margulis, Jennifer Doudna or Emmanuelle Charpentier.
G6: GENDER ISSUES IN STEM
To highlight that STEM-Jobs are not gendered: ✓ The features that define STEM jobs (curious, motivated, hard-working…) are gendered neutral. ✓ Boys can be Astronomer/Veterinary ✓ Girls can be Inventor/Engineer

To give special attention to girls in engineering: ✓ To strengthen girls' self-confidence to pursue engineer/maths studies. ✓ To highlight the social projection of engineering
To give women scientists as role models: ✓ Give special mention to female physicists, engineers and computational scientists.
GENERAL RECOMMENDATIONS (GR)
To use Social Networks (wherever possible): ✓ PERFORM has Twitter and Instagram accounts. Use them to generate dialogue between performers and students. ✓ Social network dialogue can take place during PERSEIA or promoted during PERSEIA to be made afterwards.
To foster students' interaction ✓ To invite students to make questions or to give their opinion during/after the PERSEIA.
To use videos ✓ To show a short video (3 to 5 minutes) talking about a scientific topic.

4.2 PERSEIAs design

Following the integrated methodological protocol defined in the previous section, TBVT in Spain, TRACES in France and SMS in UK adapted a performance-based activity into a PERSEIA. Not all the guidelines could be included in all three PERSEIAs given the different artistic approaches. Table 4.2 collects the guidelines followed in each case study. The PERSEIAs scripts, including those fragments where the guidelines are included, are shown in Annex 2.

Table 4.2: Recommendations included in each PERSEIA per partner.

GUIDELINES	**PARTNER**		
	TBVT	TRAC	SMS
G1: STEM JOBS			
To highlight that Science and STEM-Jobs are everywhere.	X	X	X

To highlight STEM-Jobs features that young people consider positive.	X	X	X
To highlight that some well-considered jobs are actually STEM-Jobs.	X	X	
G2: SCIENTIFIC STEREOTYPES			
To highlight positive stereotypes of science and scientists.	x	X	X
To break negative stereotypes of scientists.	x	X	X
G3: ETHICS IN RESEARCH			
To highlight that scientists do not play to be God, as all new discoveries are under ethical control.	X	X	X
To highlight that research is not only conducted to generate useful knowledge from the human being interest point of view. Ethical standards promote research on basic science.	X	X	X
G4: EU SOCIETAL CHALLENGES			
To use the EU Societal Challenges that students have considered of interest as a hook.	X		X
To take into account the local particularities.			X
G5: DIALOGUE SCIENCE AND SOCIETY			
To highlight the figure of teachers as scientists and as trustable scientific information source.	X	X	X
To include examples of current scientists.	X	X	X
G6: GENDER ISSUES IN STEM			
To highlight that STEM-Jobs are not gendered.	X	X	X
To give special attention to girls in engineering.	X	X	X
To give women scientists as role models.	X		X
GENERAL RECOMMENDATIONS (GR)			
To use Social Networks.	X	X	X
To foster students' interaction.	X	X	X
To use a video.	X		

5. PERSEIAs delivery

PERSEIAs were delivered to students in two different rounds. The first round of PERSEIA delivery took place while the last EWs were still taking place, as its aim was allowing the three case study science communicators (TBVT, SMS and TRACES) establishing a first contact with the new working methodology. Thus, this first round took partially into account the general results of the EWs.

The schools that were visited to deliver PERSEIAs were selected according to socio-economic level (the PERFORM project is addressed to low and middle socio-economic level schools) and by order of acceptance. 1,064 students in 12 schools attended PERSEIAs during the first round. Informed consents were also obtained. Schools visited are listed in table 5.3.

Table5.3: Schools visited during the first round of PERSEIAs delivery.

Case study coordinator	Name of School	Location	Date	Number of students
TRACES	Collège Les Toupets	Vauréal (95), France	14/06/2016	12
TRACES	Collège Marie Curie	Paris, France	10/06/2016	105
TRACES	Collège Jean Zay	Morsang-sur-Orge, France	16/06/2016	46
TBVT	IES Consell de Cent	Castellbisbal, Spain	23/05/2016	49
TBVT	Institut Santa Eulàlia	Terrassa, Spain	23/05/2016	49
TBVT	Institut Europa	Hospitalet de Llobregat, Spain	24/05/2016	132
TBVT	IES Consell de Cent	Barcelona, Spain	25/05/2016	127
TBVT	IES Mare de Déu de la Salut	Sabadell, Spain	26/05/2016	104
TBVT	Institut La Ferreria	Montcada i	27/05/2016	66

		Reixac, Spain		
TBVT	Abat Oliva	Ripoll, Spain	27/05/2016	272
SMS	Fairfield High School	Bristol, UK	30/06/2016	38
SMS	Brimsham Green School	Bristol, UK	14/07/2016	31

Once the guidelines were defined, PERSEIAs design was improved and redesigned accordingly. Resulting new PERSEIAs were hence delivered to 1,426 students from the 18 schools shown in table 5.4. For the evaluation of this second round the Qualia System (see Annex 2 for more information) was not used due to the low rate of response obtained in the first round. Alternatively, a new on-line questionnaire was designed. This questionnaire was completely anonymous and no sensitive data from students were included.

Table 5.4: Schools visited during the second round of PERSEIAs delivery.

Case study coordinator	Name of School	Location	Date	Number of students
TRACES	EREA Crocé Spinelli	Paris, France	29/09/2016	8
TRACES	Lycée Fénélon	Paris, France	30/09/2016	52
TRACES	Collège La Grange aux Belles	Paris, France	09/11/2016	75
TRACES	Ecole Jeannine Manuel	Paris, France	09/11/2016	20
TBVT	Príncep de Viana	Barcelona, Spain	24/10/2016	62
TBVT	Escola Virolai	Barcelona, Spain	24/10/2016	71
TBVT	IES Júlia Minguell	Badalona, Spain	24/10/2016	79
TBVT	I.P. Federica Montseny	Badia del Vallès (Barcelona), Spain	25/10/2016	83
TBVT	La Salle Montcada	Montcada i	25/10/2016	127

		Reixac (Barcelona), Spain		
TBVT	Institució Montserrat	Barcelona, Spain	27/10/2016	40
TBVT	Maristes Sants-Les Corts	Barcelona, Spain	27/10/2016	193
TBVT	IES Lloret de Mar	Lloret de Mar(Girona), Spain	28/10/2016	187
TBVT	Ramon Coll i Rodes	Lloret de Mar (Girona), Spain	28/10/2016	182
SMS	Birkenhead School	Birkenhead, United Kingdom	14/09/2016	11
SMS	St Michaels CofE School	Chorley, United Kingdom	16/09/2016	19
SMS	Leighton Middle School	Leighton Buzzard, United Kingdom	21/09/2016	25
SMS	Brooklands Middle School	Leighton Buzzard, United Kingdom	21/09/2016	22
SMS	Linslade Middle School	Leighton Buzzard, United Kingdom	22/09/2016	25
SMS	Gilbert Inglefield Middle School	Leighton Buzzard, United Kingdom	22/09/2016	27
SMS	Fullbrook Middle School	Leighton Buzzard,	23/09/2016	21

		United Kingdom		
SMS	The Castle School	Thornbury, United Kingdom	5/10/2016	7
SMS	Broadlands Academy	Bristol, United Kingdom	20/10/2016	15
SMS	Albany Academy	Chorley, United Kingdom	23/11/2016	25

6. PERSEIAs EVALUATION

PERSEIAs delivered to students were assessed in order to test if the specific guidelines to develop performance-based activities were effective in changing students' attitudes towards gender inequality and girls' barriers in STEM, science-related stereotypes, two-way dialogue between scientists and society, ethical issues in scientific research, and the role of entrepreneurial and multidisciplinary research careers in the labour market. For this purpose, *ex-ante* and *ex-post* questionnaires were designed with the assistance of University of Warwick (UoW), Universitat Autònoma de Barcelona (UAB) and Universitat Oberta de Catalonia (UOC).

6.1 Previous considerations

The following assessment of PERSEIA's delivery has been carried out beyond the objectives of the PERFORM project stated in the DoA. During the kick-off meeting TBVT, SMS, TRACES, UAB, UoW, and UOC agreed that assessing PERSEIAs delivery would provide very useful and relevant information to significantly increase the quality and confidence of the integrated methodological protocol to develop performance-based activities. Going further the initial objectives of the project, TBVT as leader of WP2 coordinated the design and implementation of an assessment methodology based on surveys with students and interviews with science communicators. Both, surveys and interviews, which are detailed in the following section, collected enough data to yield meaningful results. Nevertheless, TBVT faced two challenges that were not possible to overcome and that should be taken into consideration:

1. Students perceptions in the first round of PERESIAs delivery were assessed through a survey managed through the Qualia system, provided by UoW. This system had not the expected acceptance in schools. Qualia systems required from students that they remember an ID number that most of them forgot and, thus,

could not access to the post-PERSEIA survey. Consequently, the number of answers obtained was too low to conduct significant analysis neither cross-sectional nor longitudinally. Nevertheless, data gathered trough this system was analysed by UoW and the results obtained, although being neither systematic nor reliable, are shown in Annex 4.

2. French Case Study Coordinator, TRACES, had great difficulties in collecting students' answers to the surveys forms provided to students after PERSEIAs delivery. The number of answers obtained in this case study is not enough to provide significant results, both for the first and second rounds. For this reason results coming out of the evaluation of their data are not shown.

6.2 Assessment methodology

The methodological strategy to assess the PERSEIAs consisted on two main instruments:

1. Pre and post cross-sectional questionnaires addressed to students to evaluate their attitudes towards STEM and their perceptions regarding ethical and gender issues in science and research. Each item in the survey was related to one or more specific guidelines of the integrated methodological protocol to generate PERSEIAs so that each one could assess which of these guidelines were effective. Table 6.1 shows the correspondence between items and guidelines.

Table 6.1: Correspondence between items in survey and specific guideline

Question	EW Guidelines
Scientific knowledge is important for my future career	G1: STEM
If I wanted to, I could be a scientist	G1: STEM
Science is not for me	G1: STEM
Science is irrelevant to my life	G1: STEM
Science is usually boring	G1: STEM
Scientists follow ethical standards to pursue their	G3: Ethics

studies.	
Ethical standards are essential to pursue scientific research as improving the environment, the rights of laboratory animals or the quality of human beings.	G3: Ethics
Science helps to solve the world's problems	G4: Societal Challenges
Who do you think would do best the following jobs? [Male / Female / Either]	G6: Gender
Write the names of five scientists.	G6: Gender
Showing a video during the performance seems to me a good idea	GR
I actively participated in the performance event.	GR
Did you enjoy the use of social networks to interact with the performers?	GR

In the first round, the system used to collect students' answers was Qualia System. For the second round, the same cross-sectional questionnaires were implemented through online forms. These questionnaires' templates can be consulted in Annex 3. The number of answers collected in the second round is shown in table 6.2.

Table 6.2: Number of students' answers in pre- and post-PERSEIA questionnaires per country. In both cases, the % of respondents is calculated over the total number of attendants. Between brackets it is shown the absolute number of responses. The % of girls is calculated over the total number of respondents.

		PRE-PERSEIA		**POST-PERSEIA**	
	Attendants	Respondents	% Girls	Respondents	%Girls
Spain	1024	76.6% (785)	50.8	47.9 (490)	49.8
UK	197	95.4% (188)	47.9	55.8% (110)	47.3
France	135	41.2% (64)	41.2	12.9 (20)	65.0

2. Structured interviews to performers to gather their perceptions after the PERSEIAs delivery. Their experience in delivering the PERSEIAs complemented the information obtained through cross-sectional questionnaires. The structured interviews transcripts are showed in Annex 4. The number of interviewees per

country is shown in table 6.3.

Table 6.3: Number of performers interviewed per country.

	Performers	Interviewees
Spain	3	3
UK	1	1
France	3	1

6.3 Results

6.3.1 Students' STEM perceptions

To analyse students' perceptions towards STEM careers, the questionnaire incorporated two Likert scales with three items each: one for positive and another for negative attitudes (check Annex 3 for further information). In this sense, levels of agreement and disagreement of both scales were measured as indicators of the increase or decrease in the positive and negative attitudes towards STEM. Figure 6.1 shows the data for the positive attitudes scale in Spain and UK.

As shown in figure 6.1 all three indicators were slightly higher in the Spanish case study after the delivery of the PERSEIAs. On the contrary, science busking in UK achieved the goal of increasing positive attitudes just for some of the indicators: agreement and disagreement for "Science knowledge is important for my future career" decreased after delivering the PERSEIA, meaning that students fell into neutrality; disagreement to the sentence "If I wanted to, I could be a scientist" increases after seeing the PERSEIA. These two considerations should be taken into account for other groups working with science busking and reinforce positive attitudes.

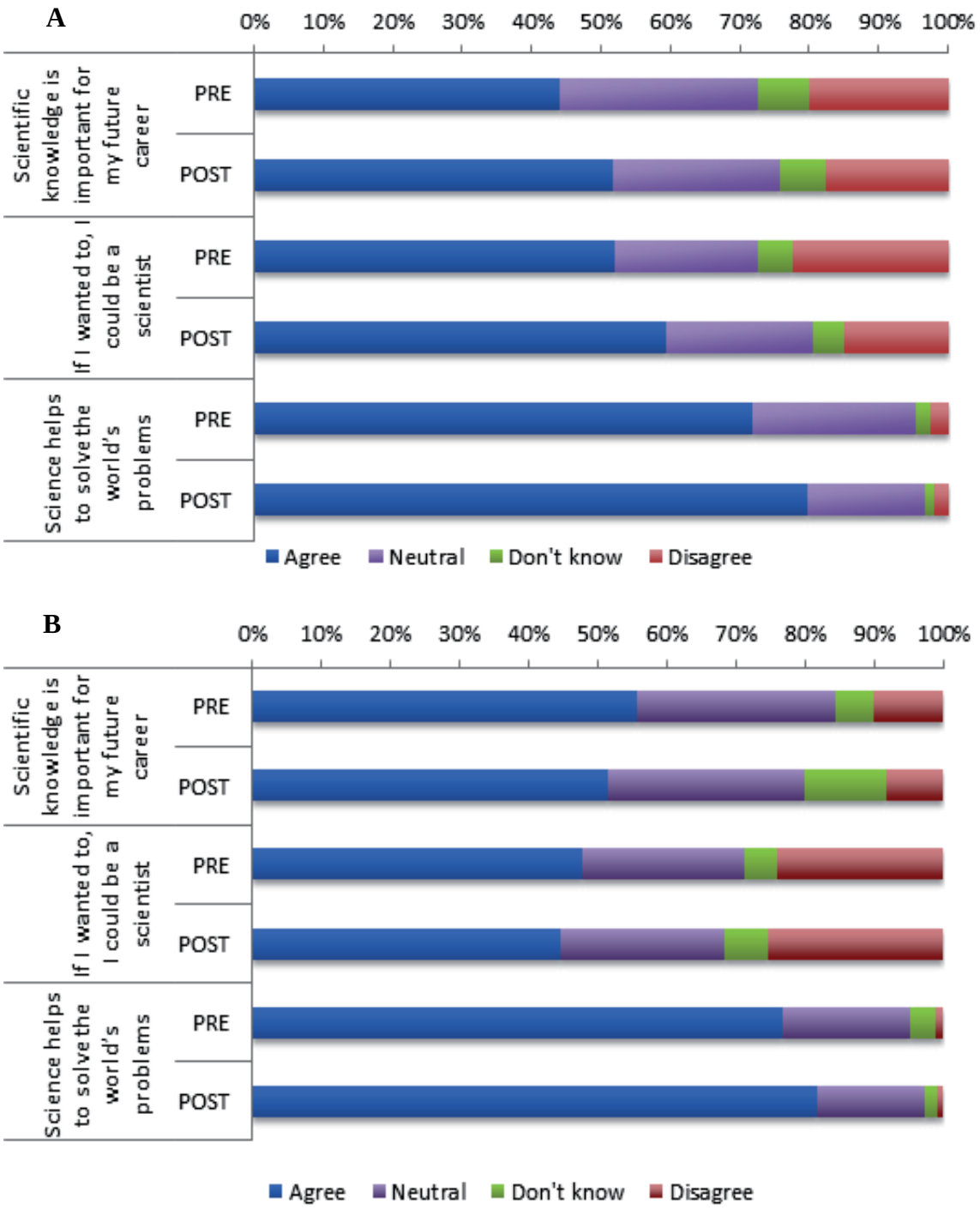

Figure 6.1: Graph showing the percentage of agreement, disagreement, and neutrality towards positive attitudes to STEM pre- and post-PERSEIA in Spain (A) and UK (B).

Both case studies results were analysed by gender to see whether there were meaningful differences among boys and girls in relation with positive attitudes towards STEM subjects and jobs. In Spain (table 6.4) there were no meaningful differences but for the indicator “Scientific knowledge is important for my future career” in which boys experienced a much higher increase than girls (12% vs. 3.3%). This fact suggests that major efforts should be put into action in further PERSEIAs to highlight the value of STEM for girls' careers.

In the UK case (table 6.5) a remarkable difference among boys and girls in their attitudes towards STEM careers can be appreciated. For the indicator “If I wanted to, I could be a scientist”, girls’ degree of agreement decreased in 11.7% while boys’ increased after the PERSEIA in 4.7%, i.e. there is a difference among them of more than 15%. As in the Spanish case, major efforts should be put into action in further PERSEIAs to highlight the value of STEM careers amongst girls.

Table 6.4: Agreement, disagreement, and neutrality by gender towards positive attitudes to STEM in Spain.

		Agree			Disagree			Neutral		
		PRE	POST	DIF	PRE	POST	DIF	PRE	POST	DIF
Scientific knowledge is important for my future career	ALL	43.9%	51.6%	**7.7%**	20.2%	17.7%	**-2.5%**	28.6%	24.1%	**-4.5%**
	BOYS	42.8%	54.8%	**12.0%**	15.0%	14.4%	**-0.6%**	34.9%	25.9%	**-9.0%**
	GIRLS	45.1%	48.4%	**3.3%**	25.2%	21.1%	**-4.1%**	22.4%	22.3%	**-0.1%**
If I wanted to, I could be a scientist	ALL	51.8%	59.4%	**7.6%**	22.5%	15.1%	**-7.4%**	20.7%	21.0%	**0.3%**
	BOYS	54.4%	60.7%	**6.3%**	22.6%	14.7%	**-7.9%**	19.3%	18.9%	**-0.4%**
	GIRLS	49.4%	58.1%	**8.7%**	22.4%	15.3%	**-7.1%**	21.9%	23.2%	**1.3%**
Science helps to solve the world's problems	ALL	71.7%	79.5%	**7.8%**	2.6%	2.2%	**-0.4%**	23.4%	17.0%	**-6.4%**
	BOYS	70.5%	77.5%	**7.0%**	1.8%	1.6%	**-0.2%**	25.6%	18.8%	**-6.8%**
	GIRLS	73.1%	81.4%	**8.3%**	3.5%	2.9%	**-0.6%**	21.1%	15.3%	**-5.8%**

Table 6.5: Agreement, disagreement, and neutrality by gender towards positive attitudes to STEM in UK.

		Agree			Disagree			Neutral		
		PRE	POST	DIF	PRE	POST	DIF	PRE	POST	DIF
Scientific knowledge is important for my future career	ALL	55.7%	51.3%	**-4.4%**	10.2%	8.3%	**-1.9%**	28.6%	28.4%	**-0.2%**
	BOYS	59.4%	51.7%	**-7.7%**	7.3%	8.6%	**1.3%**	28.1%	29.3%	**1.2%**
	GIRLS	51.7%	51.0%	**-0.7%**	13.5%	7.8%	**-5.7%**	29.2%	27.5%	**-1.7%**
If I wanted to, I could be a scientist	ALL	47.6%	44.5%	**-3.1%**	24.0%	25.4%	**1.4%**	23.5%	23.6%	**0.1%**
	BOYS	41.8%	46.5%	**4.7%**	25.5%	25.9%	**0.4%**	27.6%	25.9%	**-1.7%**
	GIRLS	54.0%	42.3%	**-11.7%**	22.5%	25.0%	**2.5%**	19.1%	21.2%	**2.1%**
Science helps to solve the world's problems	ALL	76.6%	81.7%	**5.1%**	1.1%	0.9%	**-0.2%**	18.6%	15.6%	**-3.0%**
	BOYS	77.5%	86.3%	**8.8%**	2.0%	0.0%	**-2.0%**	16.3%	12.1%	**-4.2%**
	GIRLS	75.6%	76.4%	**0.8%**	0.0%	2.0%	**2.0%**	21.1%	19.6%	**-1.5%**

As in the case of positive attitudes, indicators for negative attitudes towards science increased in Spain after delivering the PERSEIAs. The negative attitudes were reduced in all three indicators of the scale (Fig 6.2-A). In contrast, in UK the indicators for negative attitudes increased except the indicator “Science is usually boring” (Fig 6.2-B). Following the insight stated previously, these considerations should need further analysis and need to be taken into account by other groups working with science busking.

Case studies results from Spain and UK were disaggregated by gender to examine whether there were meaningful differences among boys and girls in relation with negative attitudes towards STEM subjects and jobs. In Spain (table 6.6), all three indicators showed that negative attitudes decreased for both genders, but more intensively among boys than girls. Actually, girls’ level of disagreement with regards to the negative indicator “Science is not for me” decreased in 4.7% after having participated in the PERSEIA.

In the UK case study (table 6.7), on the other hand, only the level of agreement with the indicator “Science is usually boring” decreased after delivering the PERSEIA, while the other two negative indicators increased instead of hindering. In this case, girls were less prone to diminish their negative attitudes than boys. These results suggested that science busking PERSEIA needed further revision.

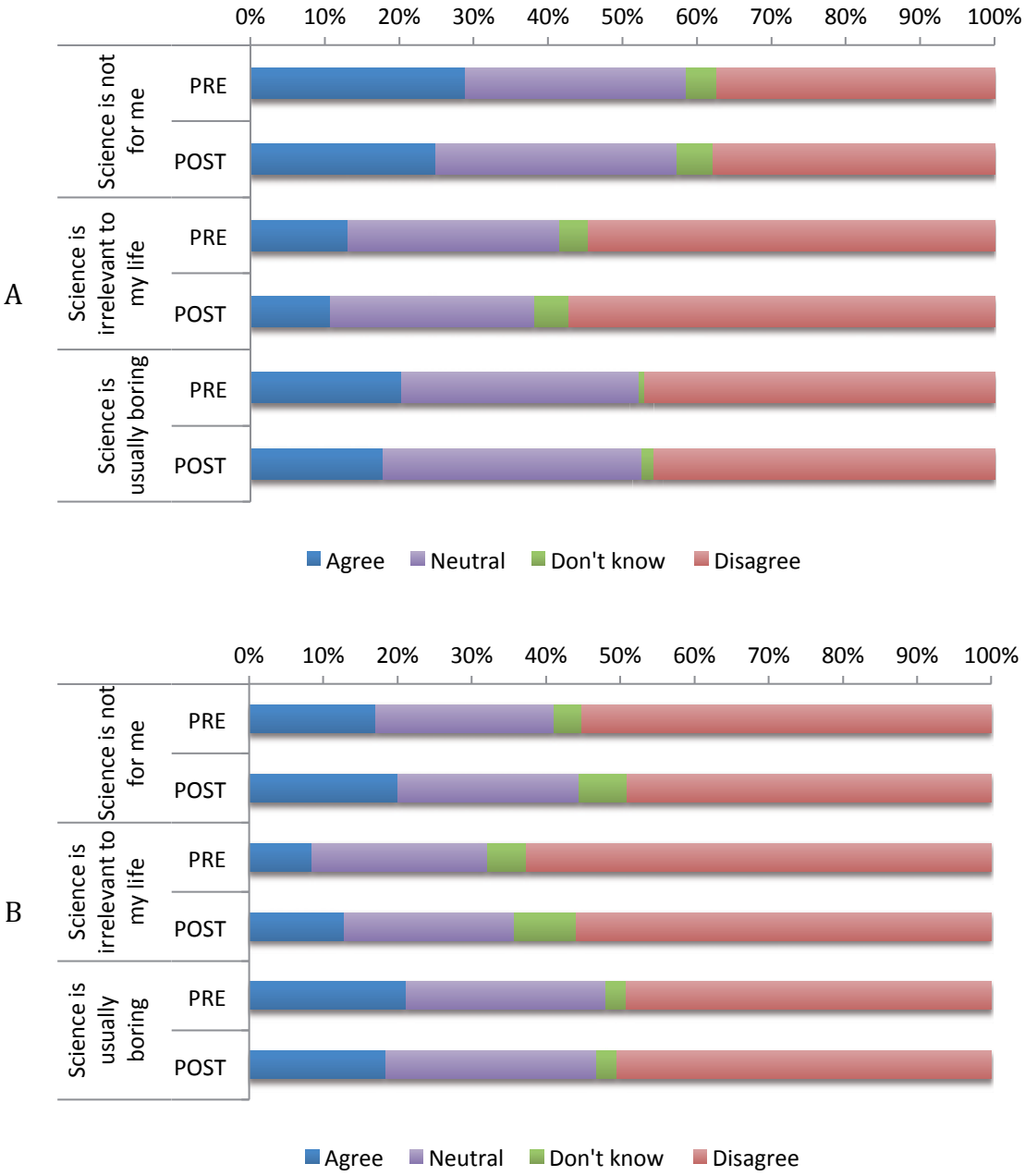

Figure 6.2: Percentage of agreement, disagreement, and neutrality towards negative attitudes to STEM pre- and post-PERSEIA in Spain (A) and UK (B).

Table 6.6: Agreement, disagreement, and neutrality by gender towards positive attitudes to STEM in Spain.

		Agree			Disagree			Neutral		
		PRE	POST	DIF	PRE	POST	DIF	PRE	POST	DIF
Science is not for me	ALL	28.9%	23.2%	**-5.7%**	37.3%	35.2%	**-2.1%**	29.7%	30.2%	**0.5%**
	BOYS	31.2%	23.5%	**-7.7%**	36.9%	37.1%	**0.2%**	28.0%	31.3%	**3.3%**
	GIRLS	26.7%	22.8%	**-3.9%**	37.9%	33.2%	**-4.7%**	31.1%	29.0%	**-2.1%**
Science is irrelevant to my life	ALL	13.1%	10.7%	**-2.4%**	54.6%	57.1%	**2.5%**	28.5%	27.4%	**-1.1%**
	BOYS	14.7%	10.2%	**-4.5%**	50.0%	54.7%	**4.7%**	31.7%	30.6%	**-1.1%**
	GIRLS	11.6%	11.3%	**-0.3%**	59.1%	59.6%	**0.5%**	25.3%	24.2%	**-1.1%**
Science is usually boring	ALL	20.3%	17.8%	**-2.5%**	47.0%	45.8%	**-1.2%**	31.9%	34.8%	**2.9%**
	BOYS	22.6%	18.6%	**-4.0%**	44.5%	43.0%	**-1.5%**	31.3%	36.8%	**5.5%**
	GIRLS	18.2%	17.0%	**-1.2%**	49.5%	48.6%	**-0.9%**	32.3%	32.8%	**0.5%**

Table 6.7: Agreement, disagreement, and neutrality by gender towards positive attitudes to STEM in UK.

		Agree			Disagree			Neutral		
		PRE	POST	DIF	PRE	POST	DIF	PRE	POST	DIF
Science is not for me	ALL	17.2%	20.0%	**2.8%**	55.7%	49.1%	**-6.6%**	24.3%	24.5%	**0.2%**
	BOYS	20.8%	22.4%	**1.6%**	57.3%	48.3%	**-9.0%**	20.8%	24.1%	**3.3%**
	GIRLS	13.4%	17.3%	**3.9%**	53.9%	50.0%	**-3.9%**	28.1%	25.0%	**-3.1%**
Science is irrelevant to my life	ALL	8.5%	12.8%	**4.3%**	62.5%	55.9%	**-6.6%**	23.5%	22.9%	**-0.6%**
	BOYS	9.2%	12.0%	**2.8%**	68.4%	56.9%	**-11.5%**	19.4%	22.4%	**3.0%**
	GIRLS	7.8%	13.7%	**5.9%**	56.2%	54.9%	**-1.3%**	28.1%	23.5%	**-4.6%**
Science is usually boring	ALL	21.1%	18.4%	**-2.7%**	49.2%	50.4%	**1.2%**	27.0%	28.4%	**1.4%**
	BOYS	18.6%	17.2%	**-1.4%**	47.4%	48.3%	**0.9%**	29.9%	31.0%	**1.1%**
	GIRLS	23.8%	19.6%	**-4.2%**	51.1%	52.9%	**1.8%**	23.9%	25.5%	**1.6%**

6.3.2 Students' perceptions of science-related ethical issues

In order to address how students see and perceive ethical concerns related to the scientists' work, the questionnaire included a 2-items Likert scale. As in the previous scales, figure 6.3, show the degrees of agreement and disagreement with those items in the two case studies analysed. In this case, the option "Don't know" is included, as its results are relevant for the study.

In the Spanish case study, both indicators are enhanced after delivering the PERSEIAs, specially "Scientist follow ethical standards to pursue their studies", which has been enhanced more than 10%. It is also remarkable that those answering "Don't know" are decreased by a rate of 5%. There are no meaningful gendered differences in the perceptions of ethical concerns regarding the scientific practice.

In UK ethical perceptions are also enhanced after delivering the PERSEIAs. In this case, though, the ratio or respondents for the option "Don't know" was higher than in Spain and was increased by the PERSEIA, reinforcing the idea that the science busking show, as a tool for transmitting RRI values, must be reformulated. There are no meaningful differences between girls and boys in their perceptions of ethical concerns.

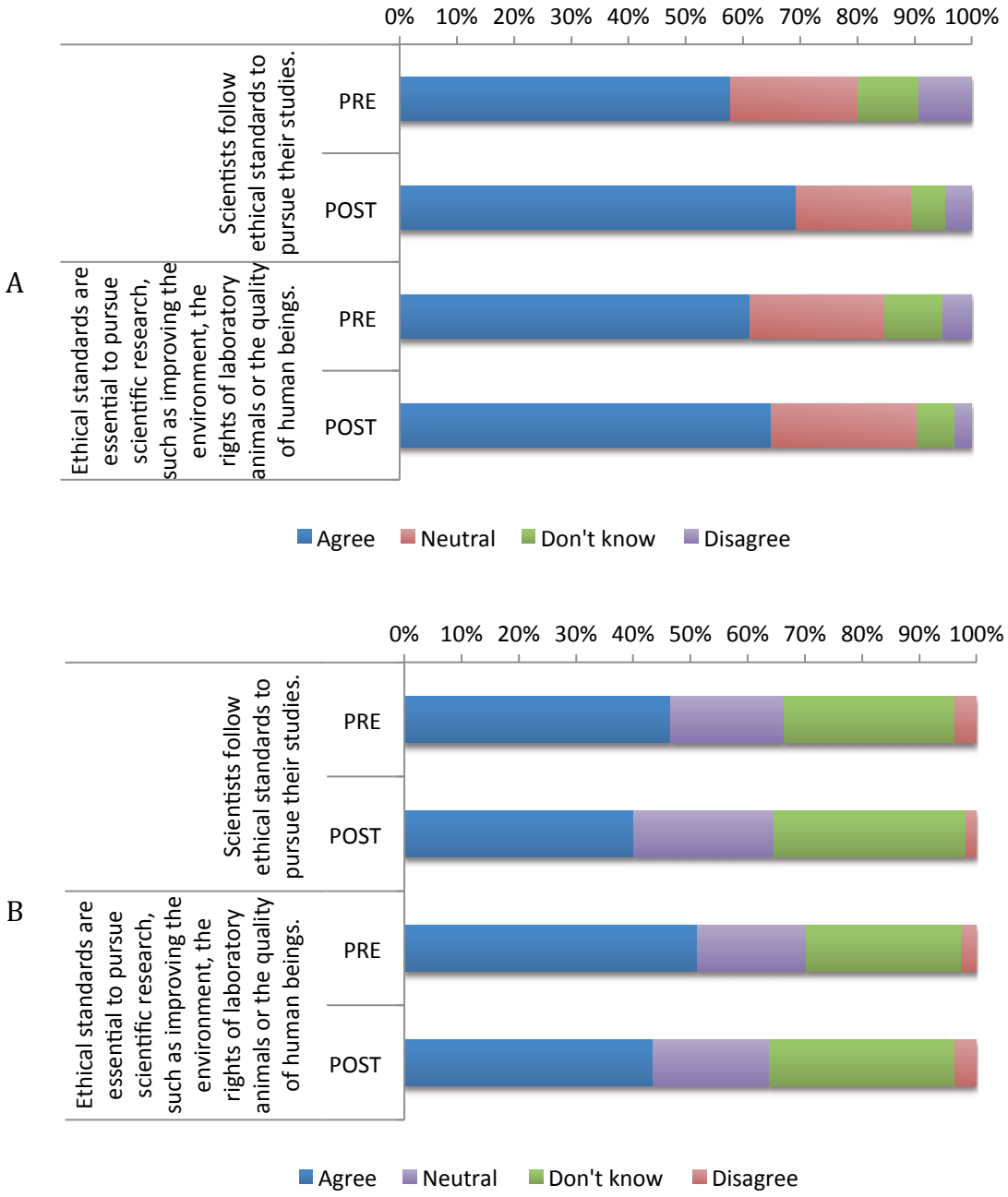

Figure 6.3: Graphs showing the percentage of agreement, disagreement, neutrality and "Don't know" option towards ethical issues concerning science pre- and post-PERSEIA in Spain (A) and UK (B).

6.3.3 *Students' perceptions of science-related gender issues*

In order to know to what extent students perceive science as gendered, pre- and post-surveys included two indicators. One of them addressed how many female scientists they knew so both pre and post-surveys included an open question about scientists they knew. Out of them, the names of "real" female scientists were counted. The second indicator evaluated how gendered they understood six different professions related to science: veterinarian, computer programmer, theoretical physicist, nurse, astronomer, and engineer.

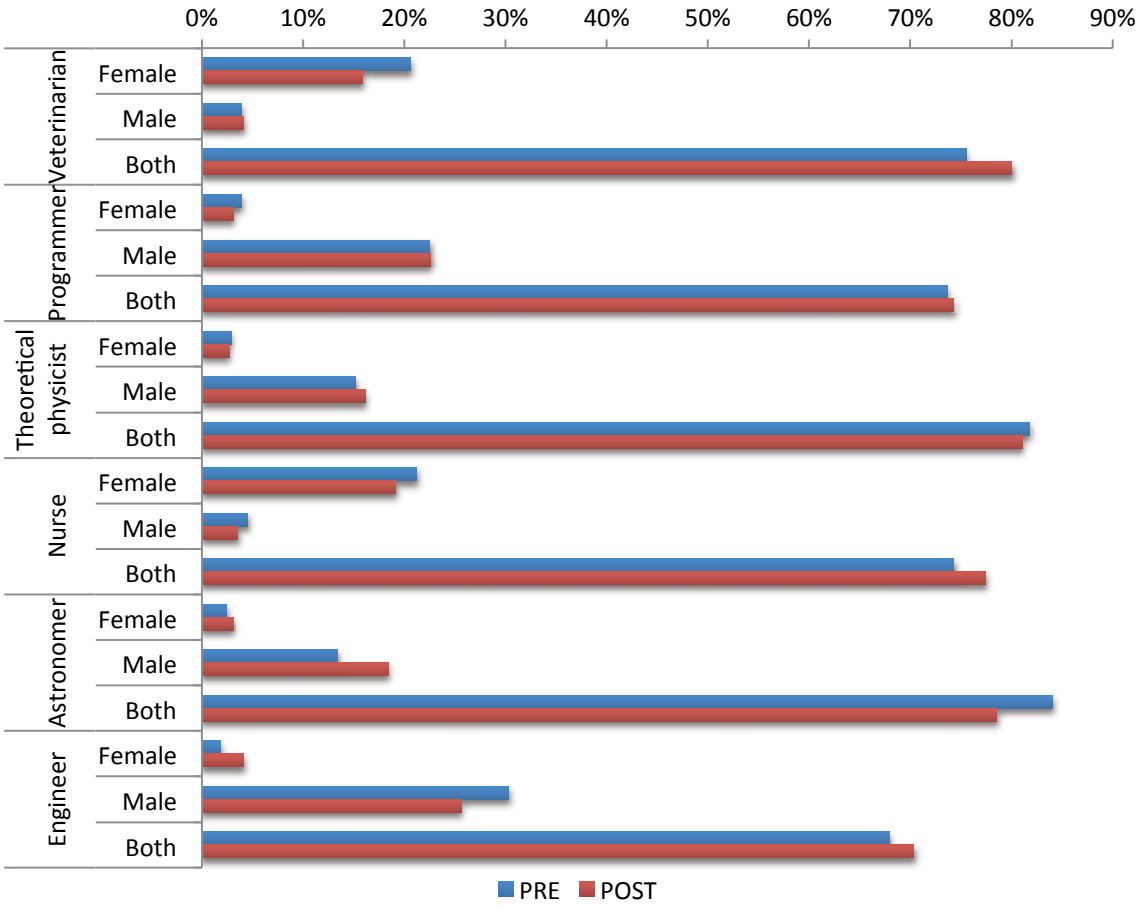

Figure 6.4: Gendered perceptions towards six scientific professions in Spain.

In Spain, 85.1% of the students taking the pre-PERSEIA survey did not know any female scientist, and this rate decreased to 82.9% after delivering the PERSEIA. Regarding to how gendered they perceived each one of the six professions, figure 6.4 shows that in general they perceived all of them as being able to be performed by both men and women. Anyway, veterinarian and nurse were slightly attributed to women whereas programmer, theoretical physicist and astronomer were more perceived as a men's job. After the PERSEIA, the perception that these professions could be carried out by both men and women increased for all cases but for the astronomer, which was even more related to men.

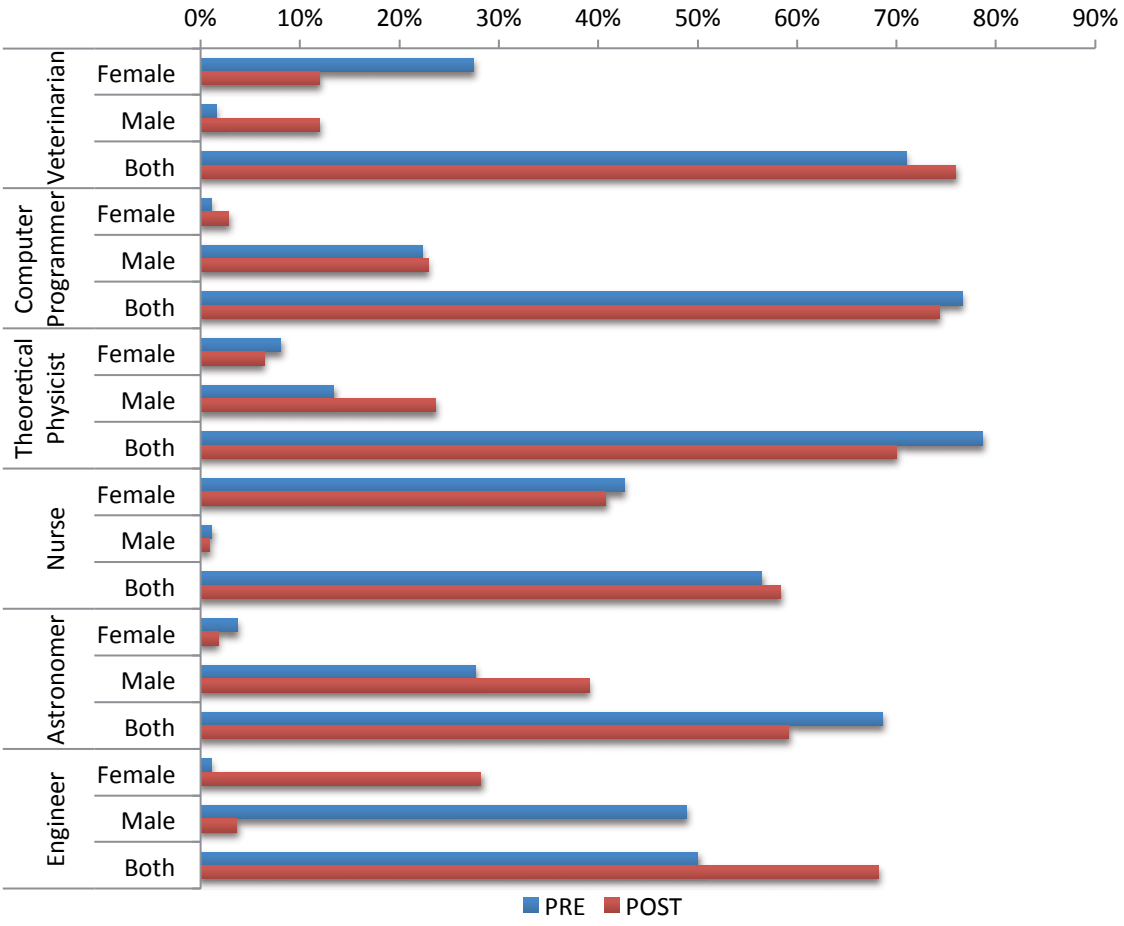

Figure 6.5: Gendered perceptions towards six scientific professions in UK.

In UK, 88.8% of the students taking the pre-PERSEIA survey did not know any female scientist, and this rate was very slightly increased to 89.2% after delivering the PERSEIA. The genderization pattern was also very similar to Spain with more than 70% of students agreeing on the six professions being performed by both women and men equally. Nevertheless veterinarian and nurse were perceived as more related to women than men, in the latter with more than 40% seeing it as a women's job, whereas the other four were perceived as more related to men. These patterns did not change much after delivering the PERSEIA but for the engineer, which increased by 25% its perception of women being engineers. Results are shown in figure 6.5.

6.3.4 Performance styles' assessment

Besides the analysis of RRI values and STEM perceptions showed below, the PERSEIAs evaluation strategy included an assessment of the performances styles through the post-PERSEIA survey using three different scales: positive perceptions, negative perceptions, and general recommendations. The former scale assessed the impact that the general recommendations of the guidelines had over the general development of the PERSEIAs delivery. These scales were complemented by structured interviews to the performers.

In Spain, all indicators for positive perceptions had a level of agreement of more than 60%. Nevertheless, students agreed in less than 40% that attending the PERSEIA was positive for their learning of science. In the case of negative perceptions, the level of disagreement was higher than 60% in all cases, even though the scientific monologues were more confusing for boys than for girls. In Spain, only 6.7% of the students did not enjoyed the PERSEIA (figure 6.6), what is consistent with the results obtained in the statement "The performance was boring", which was agreed by 12.4% of the students, and with "The activity was a waste of time" that was agreed only by 8.7% (figure 6.7). The use of monologues to talk about science did not adversely affect the image that students have of the

performers, as only 7.8% of the students did not consider the performers as scientific experts. In the same line, a reduced 4.8% of the students did not trust in the scientific information given during the performance and 13.1% considered it confusing, while 42.0% considered the performance important for their scientific learning (figure6.6).

Showing a video was a good idea for more than 65% of the respondents, especially for girls (figure 6.6). Even more, almost 30% of the students attending the Spanish PERSEIA agreed on having actively participated in the event. Actually, 27% of the students attending the event talked directly to the performers during the event (data not shown). This confirms that an important effort has been made to reach the goal of making an interactive PERSEIA, as stand-up comedy shows normally low interaction with the audience. The use of social networking applications was moderate, with less than 50% of the audience having used them to interact with the performers (data not shown). All these results are showed in figure 6.6.

In the UK, two of the indicators for positive perceptions ("I have enjoyed the performance" and "I trust the scientific information in the performance I attended") had a level of agreement of almost 80%. Nevertheless, only 50% of the students agreed on "The performers are scientific experts". In the case of the negative perceptions, the level of disagreement was higher than 70%, even though many boys positioned themselves neutrally when considering the science-busking event as confusing. The level of interaction with the audience was higher than in the Spanish case, with almost 50% of students admitting having spoken with the performers and having actively participated in the event. This fact could be due to the fact that busking is delivered with smaller audiences than stand-up (table 5.4). Only 40% of the students were engaged with social networks. All these results can be checked in figure 6.7.

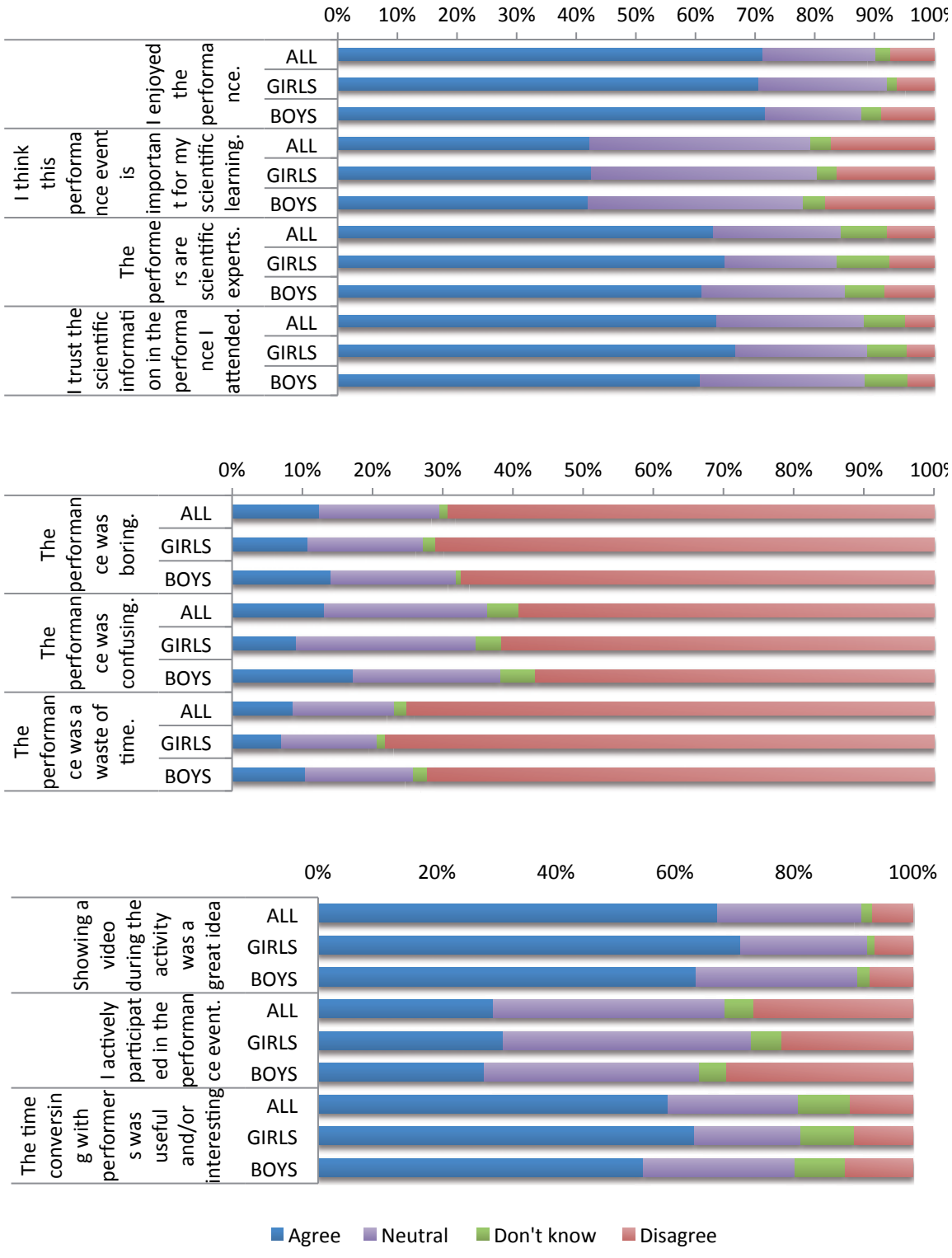

Figure 6.6: Evaluation of stand-up comedy style performance in Spain, by gender.

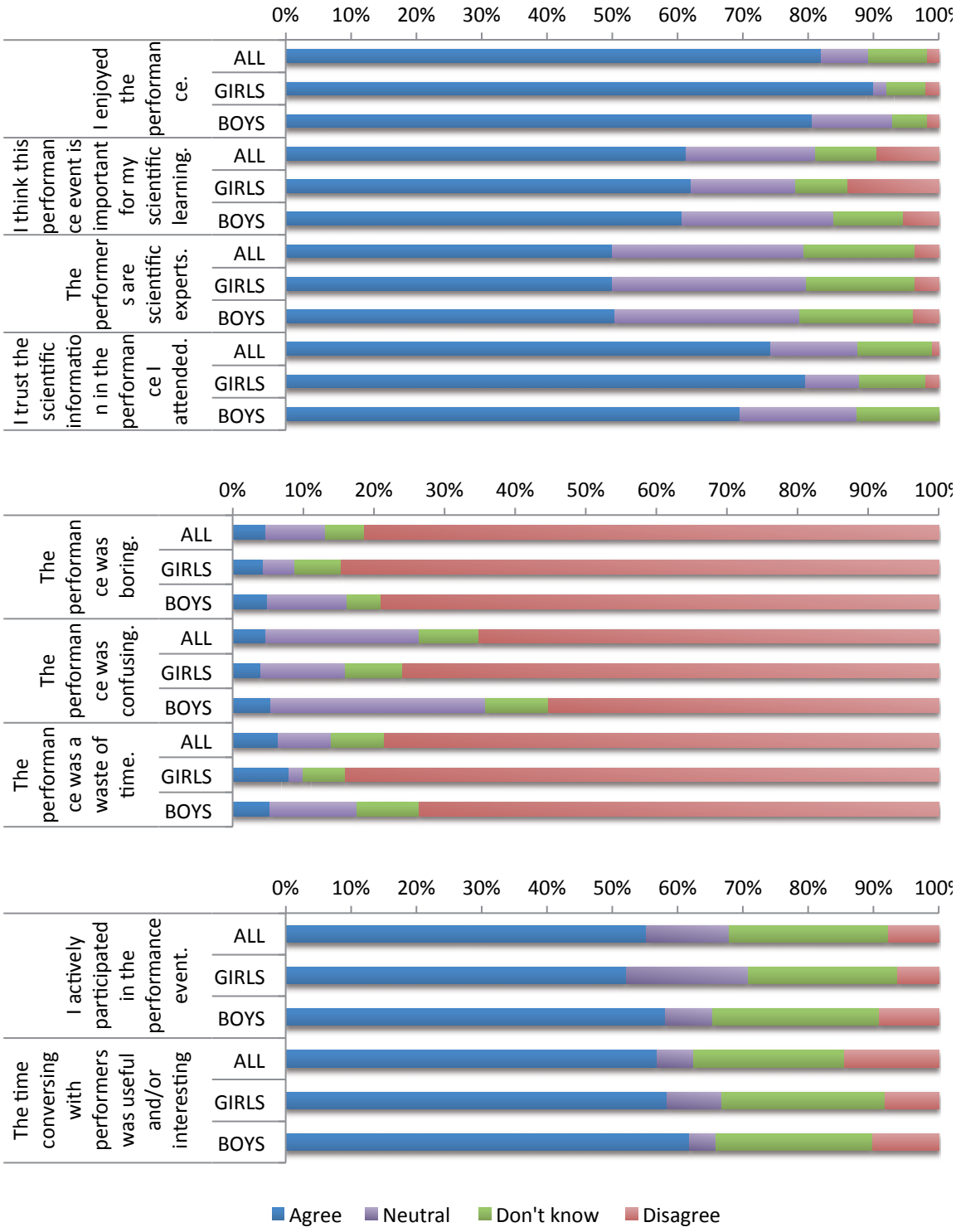

Figure 6.7: Evaluation of science-busking style performance in UK, by gender.

These quantitative results are compared to the answers given by the performers delivering the PERSEIAs in both cases through structured interviews that are included in Annex 5. In the Spanish case, students' perceptions that the performance was fruitful for their learning process was moderately high (42.3%). According to TBVT performers, PERSEIAs mediated by stand-up comedy worked because humour enhances attention.

> *"As I observed, [the elements that worked best] were passages in the text that required low concentration and offered proximity (not necessarily humour) and lively nonverbal communication." [ES_performer1]*

> *"Monologues used familiar situations. Besides, it is always great to see your mates participating in the activity." [ES_performer3]*

Other elements that helped students to better understand the PERSEIA, according to the performers, was delivering it outside the common classroom, incorporating rap music or using a video. This last question has been also evaluated through the post-PERSEIA survey, as showed before, and showed an agreement degree of 65%.

> *"It helps a lot if the performance is not inside the classroom. If possible, it is better moving to the school auditorium or to a nearby theatre. […] This makes students behave better and teachers get more involved in the show." [ES_performer2]*

> *"The use of video is a great tool. It is awesome to observe how students stay quiet and contemplating the video very concentrated." [ES_performer2]*

> *"The final rap worked very well. Rap speaks in their language." [ES_performer3]*

Even though these elements worked well, a moderate proportion of the students admitted having participated actively in the Spanish performance (30%). The performers, who claimed that they were not able to make participate students attending the PERSEIA, confirmed this appreciation. They asserted that the final round for questions usually did not work well, and that sometimes they would need some help from teachers. They admitted, in addition, that the most dense and narrative parts of the performance did not make students participate correctly. All these elements should be taken into account to better improve stand-up PERSEIA in the future.

> *"Sudden demand of collaboration, if voluntarily don't work, is tricky, so as to attracting attention by force, using clichés and overacting."*
> *[ES_performer1]*

> *"Sometimes, the questions round does not work properly, especially if they are going to the playground or home just after the performance. In those moments, the collaboration of teachers is crucial, but they usually "disappear" from the show." [ES_performer2]*

> *"Moments in which the structure was more narrative and serious did not work well at all at engaging audience." [ES_performer3]*

In the UK case study, students' perception that the activity was useful for their scientific learning was higher than in the Spanish case study. As the performer indicates, science busking showed that it worked well because the performer knew very well the audience. For this, it was necessary to listen what they said during the show and to wrap the busking show with familiar stories close to their context.

> *"[…] listening to your audience before and as you commence to busk. If we listen hard enough are audiences will nearly always tell us (whether*

they mean to or not!) how best to deliver material to them. The mobile phone routine was especially useful for this and the performer could feel the difference when time constraints sometimes prevented this element of the busking set from being deployed." [UK_performer1]

"The mobile demo is so very interactive, pupils really bought into the Harry Potter idea, with science being allied to magic in popular culture." [UK_performer1]

In addition to being useful for their learning, students actively participated in the busking. The performer, who affirmed that participation is the most important variable to make a science busking show successful, confirmed this claim.

"This mixture of wonder through participation lies at the heart of many successful science busking demonstrations" [UK_performer1]

"Questioning remains one of the most effective techniques for involving an audience in any busk. Even closed questioning can very much have its uses for engaging an audience in your subject matter at its relevance to that audience." [UK_performer1]

Considering all these results, it can be concluded that science busking artistic discipline was more appealing for students than stand-up comedy. Nevertheless, the latter showed better results to transmit RRI values and to increase STEM attitudes in secondary school students. Having these preliminary results in mind makes it even more necessary the collaboration among different groups working in performing arts and science.

In the French case study, one of the most important appreciations the TRACES performer had is that clown PERSEIAs worked so well because teenagers feel represented by the characters:

"I think the teenagers recognize themselves, and adults they live with, in some part of the show. They laugh and comment some scenes." [FR_performer1]

TRACES performer admits that using EW to adapt their performance has allowed them to better connect with teenagers.

"The fact we used the real material of the workshops we did in the classroom with teenagers worked well. What job make them dream, what vision they have about scientist? Etc..." [FR_performer1]

As in the Spanish case, one of the main problems of TRACES PERSEIA was the interaction with the audience. In this sense, French and Spanish PERSEIA need to further review their performances to include some participation of teenagers.

"It's not easy to answer this...because they didn't talk about what they didn't like after the show (in front of us!)" [FR_performer1]

"[It would have improved the show] taking more time in the sessions to really let the discussion grows up, and let us be surprised by what young teenagers have to say!!" [FR_performer1]

7. FINAL INTEGRATED METHODOLOGICAL PROTOCOL TO GENERATE PERSEIAs

Taking together all the results from the previous sections (those emerged in the EW and the PERSEIAs evaluation), this section presents the conclusion of all the work made for task 2.1 that is *per se* the final integrated methodological protocol of tested methods. This protocol will be uploaded to the PERFORM webpage as a tool for teachers, science communicators and researchers interested in drama-based approaches to develop PERSEIAs, and will be submitted to Scientix and other related science education portals such as RRI-Tools. Thus, as this section is designed to act as a single document that may be read alone, some parts might contain repetitions to previous sections of deliverable 2.1.

7.1 Introduction

The protocol you are reading is one of the main outcomes of the PERFORM research project. The main objective of the PERFORM project is to deeply investigate the effects of the establishment of a direct interaction and communication between young people and researchers in the promotion of young people's motivations and engagement in STEM. Such direct interaction and communication will be established by using innovative science education methods based on performing arts approaches, which we call PERSEIAs.

To reach this aim, we have explored key educational and communicational tools in drama based activities that address the human dimension of science and young people's perceptions and interests in STEM and RRI values. Related topics focused on gender inequality and girls' barriers in STEM; science-related stereotypes; two-way dialogue between scientists and the society; ethical issues in scientific research; and the role of entrepreneurial and multidisciplinary research careers in labour market. By using these tools to include the human dimension of science and students' concerns, perceptions and interests about STEM and RRI

values in a performance-based activity, you will convert your drama-based activity into a real PERSEIA.

To deeply understand what humanizing science is or RRI values are, we suggest to read some of the following articles and reports and to watch some of the following videos developed by other H2020 projects:

- https://www.rri-tools.eu/es/about-rri
- http://www.euroscientist.com/responsible-research-and-innovation/
- RRI. Towards an open science and innovation system that tackles societal challenges
- RRI for education community

7.2 To whom is it addressed?

The main targets of this protocol are secondary school teachers, researchers and science communicators who are interested in using drama-based activities that embed the RRI values to teach and communicate science. For this reason, those interested in following this protocol may already have a drama-based activity about science that can be converted into a PERSEIA.

7.3 What are the benefits of creating and delivering PERSEIAs? (In short: Why should I do this?)

PERSEIAs have been shown to be an effective tool to enhance students' positive perceptions and attitudes towards STEM carrers and jobs and to reflect about ethics and gender issues in science and research while having a good time watching and interacting with the performance. Have a look at students' reactions by watching this video of the PERSEIA developed in Spain, this video in France, and this video in UK.

Converting a drama-based activity into a PERSEIA will give students a new perception towards STEM and will make them reflect on RRI values. A PERSEIA goes beyond the “aseptic and rigourous” scientific content and includes ethical

concerns, societal challenges, gender issues, and addresses science related stereotypes.

Not only that, PERFORM project has proved that PERSEIAs can actually engage students with STEM. Here you will find a protocol to generate a PERSEIA that has been created and tested putting together the collaborative efforts of three science communicaton professional groups working different performing disciplines in Spain, France and the UK.

- Scientific stand-up comedy, individual monologues using jokes and humour to deconstruct *clichés* and stereotypes and explain daily life scientific activities or recent science discoveries. Developed in PERFORM by Big Van (TBVT), in Spain.
- Science clown based on improvisational theatre, an adaptation of classical clown discipline through which, combining mime, gestural theatre and humour, scientific values are explained. Developed in PERFORM by TRACES, in France.
- Science busking, an adaptation of street theatre in which spectacular and surprising experiments are perfomed in the street and public places, followed by explanations. Developed by Science Made Simple (SMS), in UK.

PERFORM research has found that transforming these drama-based activities into PERSEIAs leads to:

- Increasing positive attitudes towards STEM carrers and jobs.
- Hindering negative attitudes towards STEM carrers and jobs.
- Enhancing meaningfully ethical concerns related to scientific activity.
- Breaking gender stereotypes on many STEM carrers like nurse or engineer.

7.4 How can you do it?

To adapt already existing drama-based activities into PERSEIAs is crucial to include the human dimension of science and the values embedded in RRI. Thus, PERSEIAs have to reflect on some (if not all) of the following topics:

- **Topic 1: STEM JOBS**
- **Topic 2: SCIENTIFIC STEREOTYPES**
- **Topic 3: ETHICS IN SCIENCE AND IN THE RESEARCH PROCESS**
- **Topic 4: EU SOCIETAL CHALLENGES**
- **Topic 5: GENDER ISSUES IN SCIENCE**

There should be hundreds of ways to address these general topics. Students' perceptions and concerns about them might depend on your local context, the socio-economical level of the school you are working at, students' performance, their attitudes toward science, or the artistic discipline you are working with. As these factors are context-dependent in PERFORM we have developed a series of Explortatory Workshops (EWs) that you can organise with students to explore their specific concers regarding humanising science and the values embedded in the RRI:

- EW1 - STEM market: The role of entrepreneurial and multidisciplinary research careers in labour market
- EW2 - Stereo-science-types: Science-related stereotypes
- EW3 - Life recreation: Ethical issues in scientific research
- EW4 - Our priorities for the World: Relevant scientific topics related to current EU societal challenges
- EW5 - Guess who: Gender inequality and girls' barriers in STEM

In the following subsection you will find the specific protocols to deliver the EWs with your targeted students and a grid that will allow you to collect the important data (students' perceptions and concerns regarding science) that will be needed to convert your drama-based activity into a PERSEIA.

7.4.1 EW1- STEM market: The role of entrepreneurial and multidisciplinary research careers in labour market

Addressed Topic: STEM careers in labour market

Duration: 50 minutes.

General Objectives:

1. To understand if young people associates studying a STEM career with good jobs in the future.

Description of the EW:

Organize students in groups of 3 or 4 people. Minimum: 4 groups.

This EW is composed by two sub-activities:

1. Best Job Ever

Specific Objective: To understand which are the characteristics that young people appreciate in a hypothetic good job.

Implementation:

- Each group has to list the 5 features that their ideal job has. They have to write each one in a post-it (one characteristic per post-it). No more than 10 minutes are needed.
- Each group has to list their 5 ideal jobs for the future. Give the students 5 to 10 minutes to think about it. The jobs chosen by each group will be written in the blackboard, organized by columns (one column for each group of students). Take a photo of the blackboard with all the jobs chosen by the students (or write them down).
- Compare the jobs listed and choose the 4-5 most popular ones. Clear the blackboard and write the selected 4-5 in a same row.
- Allow the students to put the post-its with the characteristics/advantages

under the job written in the blackboard that best fits with the characteristic. Take a photo of the blackboard with all the post-its.

- Decide, by consensus with all the students, which is the best job.

2. What did they study?

Specific Objectives: To understand which careers young people associate to "Famous People".

Implementation:

- Project the pictures of the "STEM_MARKET" power point.
- After each image, ask what the students think that the person in the picture.
- Let each group answer once per picture.
- Take notes of what students answer for each picture
- Explain to the students the real studies that the person in the picture did.

Material Needed:

post-its, blackboard, projector.

Data collection protocol for EW1: see figure 7.1

Basic information about the group & workshop	
Workshop name	
Facilitator/s	
Date & time	
Teacher attending (if any)	
Number of participant students	Total: Boys: Girls:
Students' age	
Name of the school	
FG Name	

Activity	Students' responses	Facilitators' observations
Sub-activity 1- Best job ever	Attach the picture of the blackboard with the preferred jobs selected by students	
	Write down the most popular jobs (4-5) Job 1: Job 2: Job 3: Job 4: Job 5:	
	Attach the picture of the blackboard Job 1: Job 2: Job 3: Job 4: Job 5:	which are the most valuable characteristics that an employment has to have for students (highlight in bold left)? Which is de best job chosen by students (highlight in bold left)?
Sub-activity 2- What they studied	Take notes of what studies the students answer for each picture P1- Angela Merkel: P2- Lionel Messi: P3- Maria Bianchi Prada: P4- Joanne Rowling: P5- Shaquille O'Neal: P6- Taylor Swift: P7- Greg Graffin: P8- Mark Zuckerberg P9- Mayim Bialik:	

Figure 7.1: Data collection protocol for EW1

7.4.2 EW2- Life recreation: Ethical issues in scientific research

Title: Recreate life

Addressed Topic: Ethics in scientific research

General Objective: Make the students realize, verbalize and discuss about their own ethical feelings on science and innovations.

Duration: 1 hour

Description of the EW

1- Intro - 5 min

2- Facilitators draw a line on the blackboard. On the left extremity they write "impossible", on the right extremity they write "doable". There are 10 marks on the line: from 0 (impossible) to 10 (doable).

3- Students are split into 3 groups of 5 people (number of groups will depend on number of students participating in the activity).

4- Each group is given 4 cards with an innovation (see materials). The students discuss if they think that today, with modern technology and research, this innovation is more likely to be "impossible" or "doable".

5- A representative of the first group physically places the first card somewhere on the line drawn in sec. 2. The group explains to all the class the reasons why they put the card in that specific location in the line. The final position of the card in the line **must be** a collective consensus with all the students of the class. 5 min for each card.

6- Point 5 is repeted by all the groups until all the cards are placed.

7- On the extremities of the line, facilitators replace the word "impossible" by "unacceptable" and the "doable" by "desirable". Now the 10 marks go from 0 (unacceptable) to 10 (desirable).

8- Facilitators ask students if they think that some of the cards must now be moved. If they think so, the cards are moved, but once again, the final position must be a collective consensus. 15-20 minutes

9- Facilitators help the students to define "ethics" with their own words. 5 minutes

10- Debriefing. - 5 min

Material Needed:

- Set of A4 cards with some of the possible innovations from above :
    - Chose the sex of your child.
    - Bringing back to life someone who has been under cryogenic process.
    - Recreating an extinct species.
    - Merging a rabbit with a chicken.
    - Create a child who will always be top of the class.
    - Create human beings never have heart disease.
    - Transplant a pig heart in a human being.

- Know at birth how you will die.
- Create a living organism from inert matter.
- Cloning a human being.
- Make bacteria that can produce energy.
- ...

Of course other relevant ideas may be added to this list.

- Magnets or adhesive gum to stick the cards on the blackboard.
- A marker to draw the line and write the scale.

Data collection protocol for EW2: see figure 7.2

Basic information about the group & workshop	
Workshop name	
Facilitator/s	
Date & time	
Teacher attending (if any)	
Number of participant students	Total:
	Boys:
	Girls:
Students' age	
Name of the school	
FG Name	

Activity	Students' responses	Facilitators' observations
POINT 6	Take a Picture of the Bloackboard when all the cards will be located.	
POINT 8	Explain which cards have been moved by the students and the reasons thay they given	
Card Number X	Name of the invention: Moved from X to Z Reasons given by students to move	
Card Number X	Name of the invention: Moved from X to Z Reasons given by students to move	
ADD as "Card Number X" sections as you need		
POINT 9	Take a picture of the Bloackboard when all the cards will be RE-located.	
	Take notes about the definition of ethics that rise from the students.	

Figure 7.2: Data collection protocol for EW2.

7.4.3 EW3- Our priotities for the World: Relevant scientific topics related to current EU societal challenges

Faced Topic: EU societal challenges

Duration: 55 min

General Objective:

1. To make students think about what is a societal challenge.
2. To identify if young people's perception about societal challenges coincides with the EU Societal Challenges.
3. To identify ways to talk about EU Societal Challenges with/to young people.

Description of the EW:

A terrible disease strikes at once EU politicians of all countries, who are unable to attend an important congress. In that congress, politicians have to decide in which societal challenges they are going to invest EU resources during the next 4 years.
As politicians cannot attend the congress, students have to take the decisions.
In this fiction scenario, students are asked, as themselves, to decide in their stead on what are the big challenges that the world is facing and that we should focus our efforts on.

1. Presentation of the scenario - 10 min
2. Students are asked to reflect individually about what is the most important challenge to them and write it on a post-it note - 10 min
    - *Only one or two keyword for each student.*
3. The facilitator writes on the blackboard the titles of the 8 EU Societal Challenges (up to now refered as EU TOPICS) in columns, and a 9th column called VARIOUS. The facilitator briefly explains each EU topic. - 5 min
4. Students stick their post-its under the most appropiate column (according to their own perception) - 5 min
5. Students are split in 4 groups of 4 (number of students in each group will depend on the final number of students attending the activity).

6. Facilitator(s) give(s) 2 blank cards (one for each topic) to each group. The facilitator distributes the topics among the groups (two topics per group. “Various” topic is excluded) 5 min
7. For each EU topic, students have to distribute the challenges (written in the post-its) in order of relevance (according to their own perception) - 15 min
8. Facilitators draw a line on the blackboard. On the left extremity they write “LESS RELEVANT”, on the right extremity they write “MOST RELEVANT”. There are 8 marks on the line: from 0 (less relevant) to 8 (most relevant).
9. All the students stick in the blackboard their cards. In a global discussion, students have to discuss why they think each EU topic is important and have to find a consensus on the order of EU topics’ importance. - 15 min

Material Needed:

- blank post-it notes,
- pencils,
- a board/empty wall,
- 8 A4 blanks cards.

*Remember that current EU Societal Challenges are:

1. “Health, demographic change and wellbeing”;
2. “Food security";
3. “Sustainable agriculture and the Bio economy”;
4. “Secure, clean and efficient energy”;
5. “Smart, green and integrated transport”;
6. “Climate action and environment”;
7. “Inclusive, innovative and reflective societies”;
8. “Secure societies -freedom and security”.

Data collection protocol for EW3: see figure 7.3

Basic information about the group & workshop	
Workshop name	
Facilitator/s	
Date & time	
Teacher attending (if any)	
Number of participant students	Total:
	Boys:
	Girls:
Students' age	
Name of the school	
FG Name	

Activity	Students' responses	Facilitators' observations
POINT 4 Writte the list of challenges, in the order chosen by students, for each EU topic	Take a picture of the blackboard with all the post-its. Make sure that post-its Number of pos:-its in column VARIOUS: List of the challenges written by the students that goes to column VARIOUS: EU Topic 1 Heath, demographic change and wellbeing: EU Topic 2 Food security: EU Topic 3 Sustainable agriculture and the Bioeconomy: EU Topic 4 Secure, clean and efficient energy: EU Topic 5 Smart, green and integrated transport: EU Topic 6 Climate action, and EU Topic 7 Inclusive, innovative and EU Topic 8 Secure societies -freedom	
POINT 8 Take notes about the reasons and the arguments that students use to distribute the EU topics by importance	Take a picture of the blackboard with EU Topic 1 Heath, demographic change and wellbeing: EU Topic 2 Food security: EU Topic 3 Sustainable agriculture and EU Topic 4 Secure, clean and efficient EU Topic 5 Smart, green and integrated EU Topic 6 Climate action, and EU Topic 7 Inclusive, innovative and EU Topic 8 Secure societies -freedom	

Figure 7.3: Data collection protocol for EW3.

7.4.4 EW4- Science and me: Two-way dialogue between scientists and society

Addressed Topic: Dialogue between scientists and society

Duration: 60 - 90 minutes (depends largely on student numbers)

General Objectives:

1. To learn how students currently interact with science and scientists.
2. To learn how students would like to interact with science and scientists.

Description of the Workshop

1. Set up - organising the students and tables (5-10 minutes)

- Group students in pairs
- Arrange the pairs into four teams
    - If the number of students is less than 16 split them in three teams.
- Assign each team a colour (red, blue, green and yellow) and give each student a copy of the interview sheet corresponding to their colour.
- Arrange tables so that each one contains a pair from each team and sit students so that they face their partner. Ideally tables should contain 8 students but this will vary depending on the number of students in the session.
    - Try to avoid tables of less than 6 students
    - Ensure that each table only has one pair from each team.

- Note down how many teams you are using, what colours they are, and how many students are in each one.

2. Speed interviewing – see diagram for more information

- Students on side one question side two about their topic and note down their responses on the interview sheet.
    - Note: students should not write down their own answers, only the answers they get when interviewing people.

- Students on side two question side one about their topic and note down their responses on the interview sheet.
    - Note: students should not write down their own answers, only the answers they get when interviewing people.
- Students on side two switch places so that they are facing a new student on side one and the first two stages are repeated.
- This repeats until all students on side two have faced all students on side one.
- Timing depends on the number of students on each table:
    - Tables of 6 students = 18 minutes
    - Tables of 8 students = 24 minutes

3. Presentation of Results

- Students go back to their original teams based on colour (red, blue, green and yellow).
- Students discuss their results.
- Each team then has 3 minutes to present their findings to the room; they may want to nominate a spokesperson.
- Plenary discussion about the results could follow if time allows.
- Timing partly depends on the number of teams being used:
    - 10 minutes to discuss results and plan presentation
    - If 3 groups were used = 9 minutes for presentations (allow 15 for switching groups each)
    - If 4 groups were used = 12 minutes for presentations (allow 20 for switching groups etc.)
    - 5 minutes to discuss results if time allows
- Facilitators collect interview sheets from the students and also note down the key findings from the presentations for each topic.

Interview topics

The interview sheets have suggested questions on each topic that the students can ask when interviewing. Students can ask their own questions to find information about their topic if they like. Bellow are the basic topics that each team are working on (see figure 7.4).

- **Blue Team:** Should we know what scientists are doing?

Specific objectives:

a. To understand whether young people think it is important to know what scientists are working on and their results.

b. To find out if students think that the results of certain sciences should be communicated more than others.

- **Red Team:** Where do people go to find out about science?

Specific objectives:

a. To find out where young people find their scientific information.

b. To find out whether they are aware of trustworthy sources and critically assessing the information they find.

- **Green Team:** How many people have ever met a scientist?

Specific objectives:

a. To understand whether young people recognise people in everyday situations as scientists.

b. To find out how many students know or have met a scientist.

c. To find out what things young people would like to ask a scientist.

- **Yellow Team:** Who wants to take part in some real science?

Specific objectives:

a. To understand whether young people think citizen science is important and whether it would increase their interest in science.

Materials Needed:

Interview sheets for each student, a pen/pencil for each student

(Optional: clipboards)

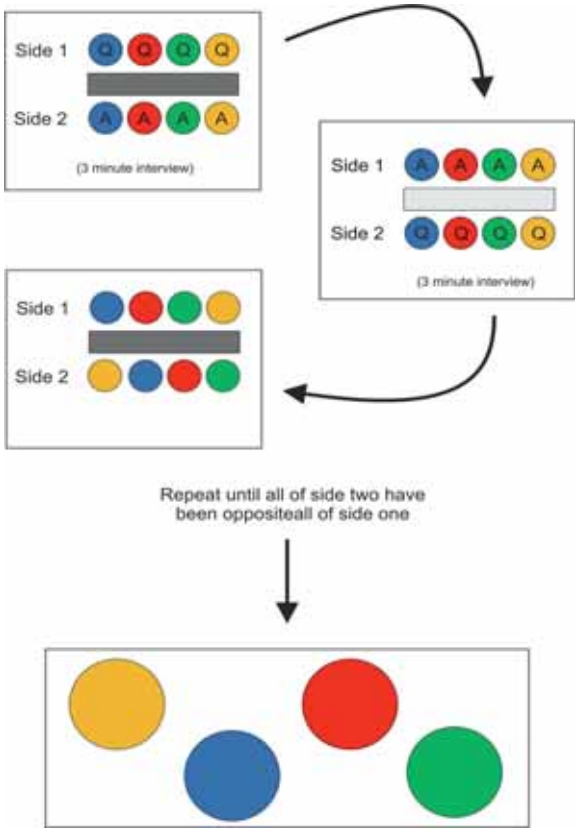

Figure 7.4: Diagram of the EW4 activity plan

Data collection protocol for EW4: see figure 7.5

Basic information about the group & workshop	
Workshop name	
Facilitator/s	
Date & time	
Teacher attending (if any)	
Number of participant students	Total:
	Boys:
	Girls:
Students' age	
Name of the school	
FG Name	

Activity	Students' responses	Facilitators' observations
	Take notes about the conclusions and findings of the students	
Stage 5	Blue table: Red table: Yellow table: Green table:	

Figure 7.5: Data collection protocol for EW4

7.4.5 EW5- Guess who: Gender inequality and girl's barriers in STEM

Addressed Topic: Gender inequity; girls' barriers in STEM

Duration: 50 - 65 minutes

General Objective

1. To find out whether students feel that certain STEM jobs are gender stereotyped and why they think that is so.

Description

1. **Who has a job like that? (5-10 minutes)**
   - Organise students into groups of 3-4.
   - Give each group a STEM job from the following list and some post-it notes (different colours per group):
     - Inventor
     - Vet
     - Chemist
     - Astronomer
     - Geologist

- Give the groups 5 minutes to write down 5 things on different post-it notes that characterise the people that do that job.
- Take pictures of the post-its of each group around the associated job.

2. Word presentation and discussion (35 minutes)

- Groups present their words and discuss why they were chosen.
- Post-it notes are collected by the facilitator.
- The facilitator will take each word in turn and get the whole group to vote on each word as to whether it is best suited to a man, a woman or neither (gender neutral) and discuss why they think that. The facilitator stick the post-it notes on the board under "Male", "Neutral" and "Female".
- Note down these words along with their gender association and the reason why.
- Look at the final outcome. Discuss any jobs with lots of "male" words or "female" words. The coloured post-it notes will help remember which jobs those words were associated with.
- Discuss any interesting points with the students such as:
    - Links between intellectual jobs being associated with male or female?
    - Links between physical jobs being associated with male or female?

3. Videos (15 minutes)

- Show videos after the activity to generate discussion on where these stereotypes come from
    - Always #likeAGirl:
    - A Man's a boss, a woman's bossy:
- Allow students to re-assess their words based on the discussion.
- Take pictures of the new word locations.

Possible variation:

- Split the students into groups of boys and girls and get them to all write 5 words to describe the people working in the same job.
- The activity would then continue as before, however, the different coloured notes would now highlight whether boys and girls use different describing language and whether they view the jobs in different ways.

Materials Needed: Post-it notes in different colours, pens/pencils, board to put post-its on

Data collection protocol for EW5: see figure 7.6

Basic information about the group & workshop	
Workshop name	
Facilitator/s	
Date & time	
Teacher attending (if any)	
Number of participant students	Total:
	Boys:
	Girls:
Students' age	
Name of the school	
FG Name	

Activity	Students' responses	Facilitators' observations
Take a picture of the groups of post-it around each job		
Write down the words typically male or female and try to identify with the students why are they gendered-biased		
Word 1:	¿Male related or Female related? ¿Why?	
Word 2:	¿Male related or Female related? ¿Why?	
Word 3:	¿Male related or Female related? ¿Why?	
Word 4:	¿Male related or Female related? ¿Why?	

Figure 7.6: Data collection protocol for EW5

7.5 Conversion of performance-based activity into a PERSEIA

After collecting and analysing the data emerging from your EW, is time to adapt your performance-based activity into a real PERSEIA following your own guidelines.

Out of these EW, PERFORM members outlined a list of general guidelines that combine the results of the EW, important ideas coming from the literature, and the own experience of the professional science communicators.

Thus, the following guidelines emerge from PERFORM experience and have been followed to generate the PERSEIAs that can be checked in annex 3. Here we show the guidelines (tables 7.1-7.5) and some examples of how to include them in performance activities based on Scientific Stand-up (TBVT), Busking (SMS) and Clown (TRACES):

Table 7.1: Guidelines for topic STEM jobs

Guidelines addressing Topic 1: STEM JOBS
To highlight that Science and STEM-Jobs are everywhere: ✓ An excavation, an electoral survey, an architectural studio, a plane, an engineering company, the zoo, a football team, in science communication events.
To highlight the STEM-Jobs features that young people consider positives: ✓ Travelling, helping others, having a flexible schedule, involving hands-on activities, reducing injustice.
To highlight that some well-considered jobs are actually STEM-Jobs: ✓ Architect, airline pilot.
To highlight the figure of teachers as scientists and as trustable scientific information source: ✓ Teachers are actually scientists.

It is a challenge to make students aware of STEM jobs are everywhere, so they can understand the importance of studying science and technology, not only during secondary school but also in higher education. The perspective of many

students is that a STEM career gives you the possibility of doing research in a lab or teaching science, but they are not aware of the different jobs in which STEM knowledge is needed. To overcome this lack of information about STEM jobs, PERFORM implemented specific actions throughout the PERSEIAs. For instance, TBVT PERSEIA opens with a one minute video showing four scientists working in their own labs (that happen to be the performers themselves) and explaining briefly their own disciplines: physics, biomedicine, chemistry and biotechnology applied to renewable energy.

To convey what is being said in the PERSEIA in something relevant for the students, our advice is that performers do not relate to other people's experiences or talk generally. It is much better to personalise what is being said, that what performers explain during the show are their own experiences, authentic and real (even if they are not, this is “performing arts”).

During the Spanish PERSEIA, TBVT performers (who are actually real scientists) talk about their own experiences working in science-related jobs, from research to industry:

… and now look at me. I became an entrepreneur; I created my own company to communicate science. Thus, I work on what I really want to: joining arts and science.

Finally I became genetic engineer and I can modify genes. To do so I had to study biology and physics.

We are aware that this suggestion will not work for some of the target audiences for this protocol, as they are not practicing scientists (e.g. most science teachers). In this case, a good alternative is to show a video with real practicing scientists.

During EWs in Spain, students underlined some positive features that STEM careers actually have, like travelling or learning foreign languages. In the Spanish PERSEIA these features were highlighted using jokes and relating them to a

European Union ERASMUS programme for university students' exchange:

> When you enter University, you will have many chances to travel abroad, for instance, ERASMUS programme. I said ERASMUS, even if you know it with the name of *orgasmus*, sorry for the disappointment

Because students often do not relate some of their "well-considered jobs" with science or technology, do not hesitate to highlight the more scientific and technological aspects of jobs like an entrepreneur, video-game designer or doctor in your future PERSEIAs. For example, TBVT creates a stand-up scientific monologue talking about the science behind mobile phones and computing language (binary code). You can consult the entire script in Annex 3.

Linking knowledge with the emotional dimension is very effective in capturing students' attention and making relevant what is being told. Through TBVT monologues, PERSEIA students are invited to think in what they really like, in which activity they are comfortable, because it will give students hints about what career they would like to choose. In this case, the performer himself explains, in a funny way, how he decided to study chemistry:

> …and it is an election season, you have to choose and there are a lot of options. You can do a training cycle, get to work or go to college. Which option do you choose? What is the good one? We at TBVT have it clear. You must choose… what you like!
>
> In high school I asked myself ... Orilo, what do you like the most?
>
> And I realized that what I was most passionate about was controlling the massive release of energy in short periods of time due to molecular reorganization ... to blow things up! So I chose the chemistry career. And it was a success, because as I chose what I liked, when I got to university I met people like me, I discovered that I was not alone, I made many friends.

A good way to catch the attention of the audience is to use graphic examples close to the students. In the busking PERSEIA, SMS tells students about the need to mix science, engineering and math to save arms, legs, and even lives, in childrens' playgrounds. They made an interesting experiment, asking two volunteers to throw

two eggs against the ground. One of them fell on a bubble wrap surface and did not break, while the other shattered on the ground. The egg that survived did so thanks to the joint work of mathematicians, scientists and engineers, showing that STEM jobs are everywhere (even playgrounds), while highlighting their most positive characteristics.

Now my good pal Nikki from Cardiff University tries to work out how to save our arms and legs (and lives!) by pulling people up to the ceiling on a rope, dropping them and seeing what happens when they hit the floor! And I need 2 volunteers to help me do just that? Thank you so much for volunteering, but really our insurance would never let us drop anyone from such a height, but amazingly I have 2 volunteers here who have both signed a piece of paper saying its fine to drop them! They are called Eggwood and Eggweena.

Busker hands the eggs to the volunteers and gets them first to drop the eggs onto a super soft floor (bubble wrap) and then on to a hard floor.

Nikki and her medical engineering pals use their science and maths skills to create super soft floors in play grounds to prevent what just happened to Eggwood and Eggweana happening to us! Science and engineering are everywhere, playgrounds are full of them!

And no matter how many times things don't work out (a lot!) Nikki and her pals keep on dropping things, keep on gathering evidence and thinking. Persistence is important as a scientist!

Table 7.2: Guidelines for topic STEM stereotypes

Guidelines addressing Topic 2: SCIENTIFIC STEREOTYPES
To highlight positive stereotypes of science and scientists: ✓ External recognition, knowledge motivation, long term goal. "Knowledge gives you power: the more you know, fewer lies you will believe" ✓ Imaginative, self-confident
To break negative stereotypes of scientists: ✓ Freaky, nerd, boring, bad couple or parent, social rejection, unable for social relations, always «ON» and in their own world

A valid way to break stereotypes is to show real scientists (or performers acting as scientists) who contradict the classic science related stereotypes:

Scientific Stereotype	Performer
Senior man	Young man & young woman
Crazy and asocial	Communicative and humorous skills
With a discourse far from the interests of adolescents	Who knows their tastes and relates them to science
Poorly dressed	Dressed in a manner similar to adolescents

In SMS PERSEIA they found a funny way to do that. The performer came into the room, wearing a football shirt underneath a tabard, underneath a lab coat and goggles holding a boss stand and clamp (see figure 7.1).

Figure 7.1. SMS performer tackling scientific stereotypes.

Hi all my name is David and you have to try and guess my profession! Nice one, you got it right I am a scientist, but does that mean science is all I do?

Busker plays table tennis, and dances with the teacher present.

I have likes and dislikes outside of what I do just like anybody else! Some scientists do see a lab coat as some sort of uniform, but that's not to say they think this wholly defines them!

During the PERSEIA, once students seem to empathize with the image of the modern scientist, is the right time to introduce the concept that being studious and geek is not bad. In TBVT PERSEIA directly break negative stereotypes by relating the stereotypes identified during EWs and saying that are false:

... students have always associated us with many stereotypes and prejudices ... that we are boring, that we do not have social life because we are always working in our laboratories, we are always on and we talk weird ... Well, that is all false!

And also not only highlighting positive stereotypes but also converting negative stereotypes into positive ones:

Well, not false at all. There is something that is true: we are geeks! I'm very geek, the rest of my mates who are going to leave here, you're going to freak out ... And I'm sure there are also geeks here ... and nerds ... well I was a nerd, and that's fine. Today we bring a message of positivism here: geeks and nerds of the room: We are with you!

And now we will give a big applause to nerds and geeks!

When you study, read and eventually become a scientist, you became creative. You can imagine how to solve problems by creating imaginative solutions; for instance, remember the scientists who created the lasers to detect gravitational waves or the engineers that made the banana-automatic-peeler. These kinds of things change the World.

To break negative stereotypes, TRACES used in their PERSEIA the traditional structure of "ready clown/ silly clown". While the silly clown highlights the negative stereotypes of science, the ready clown is able to contradict all the arguments and emphasize the good things that science has:

Silly Clown.- Scientist, why not pilot or architect. Scientists it is not a job, you will be badly dressed, badly dressed, you will have no friends, only colleagues. There will be no girls.

Ready Clown.- Ah, there are girls!

Silly Clown.- Ha! Women with beards, yes! You will speak an obscurantist language that no one will understand, except the five colleagues who will do the same research as you do. […]

Ready Clown.- Oh ... No, not at all ... Well, maybe later ...

I want to ... The ground. Plants, ants. The sky with -*Pif paf paf (stars that appear)*- stars. Messages between the tree and the stars. The mechanism of walking. The inside of the body, the digestion, what it does to you in the head, and what it does to the mom in the head. It's crawling! There's a world in there!! Where they are? The links between things.

I must know.

Table 7.3: Guidelines for addressing ethics in research

Guidelines addressing Topic 3: ETHICS IN SCIENCE AND IN THE RESEARCH PROCESS
To highlight that scientists do not play to be God, as all new discoveries are under ethical control: ✓ GMO, Artificial Intelligence/Robots, medical advances (cloning, genetically modifications in humans)
To highlight that research is not only conducted to generate useful knowledge from the human being interest point of view. Ethical standards promote research on basic science as: ✓ Improve the environmental quality ✓ Generate basic knowledge to improve nature understanding ✓ Ensure animal rights

When talking about ethics, a very useful tool is to capture the attention of the audience putting the focus on them, for instance, asking their opinion.

TBVT created a monologue talking about genetic engineering and the use of the new genetic editing tool CRISPR/Cas9. They took advantage of the use of social media during the PERSEIA and created a survey on Twitter asking the students: Would you change your genes?[1] Once the students are engaged with the ethical topic because the focus is on them, it is possible to go deeper and further in this issue. After launching the Twitter survey TBVT says:

> We scientist don't play to be God, copy-paste genes to create new species or just to see "what would happen if". We do follow very strict ethical standards, we want to help humanity, not destroy it! We are supervised by the big-brother, an international committee that prevents experiments outside ethical standards.

SMS use an original way to put the focus on students before addressing ethical standards. The busker performer complains that they would love to get to know everyone in the room personally, but there is just not time for this, so the best he can do is to shake the hands of 3 pupils in the audience and then get them to shake everybody else's hands! Prior to pupils entering the room, the busker has covered his hands in fine silver glitter, and after some other busk experiments, the performer said:

> Hands up if you have some glitter on you? Wow nearly everybody in the room! What if instead of glitter that had been a really infectious disease, we might have all got really ill! Some diseases can spread that fast!
>
> So if I said that some scientists were trying really hard to help deadly diseases spread even faster (in a laboratory!) would you agree with that? NO, why not? *(Busker gathers opinions).*
>
> Well said people! But ethically we have to ask why the scientists are doing this

[1]Look at General Recommendations above for more information about this action.

research? And for the most part it's so we can better understand how these diseases spread so fast so that we can become better at stopping them.

Scientists are very carefully regulated in their work, no way would they get funding if there was anything suspect about their research into such deadly diseases.

A different approximation to this topic is the case of TRACES PERSEIA. With a heavy load of irony, TRACES represents a mother who goes to the doctor to have a custom-made child. The situation is so exaggerated that it allows students to understand that it is not possible, and the sketch concludes by saying that science does not proceed without control, science follows ethical standards (see figure 7.2).

Figure 7.2: Picture of the fragment of TRACES PERSEIA addressing ethical issues.

Scientist.- Intelligent as his mother. Great as ... finally brown. The eyes of his mother, or the young eyes of a while ago. And what temperament! You remember when he was broken ...

Mother.- I am not ready to give birth to a young person whose life would be

suspended at the slightest breakdown of battery.

Scientist.- But do not worry, I will operate it at birth, I will put a battery built into the leg.

Mother.- Oh, how brilliant you are, what spirit. But wait, the battery should be charged constantly!

Scientist.- But do not worry, we will install a kinetic energy system that will convert the movements of the walk into electricity!

Mother.- But we will have a connection problem, we would have to square a USB port somewhere on the body.

Scientist.- But no, we can use the induction, so it will suffice that he put his laptop in a pocket and it will recharge itself.

Mother.- But can we do it right away?

Scientist.- Yes, there are still some improvements to be made, but it is a matter of time.

Mother.- But I want you right away ...

Scientist.- But we are not going to give birth to a child so that it has problems of battery when it will be great! It's not ethical. I do not want a child who is suffering! Only when all the technology will be ready, it will be applied.

Table 7.4: Guidelines for addressing EU societal challenges

Guidelines addressing Topic 4: EU SOCIETAL CHALLENGES
To use the EU Societal Challenges that students have considered of interest as a hook. Take into account your local particularities, i.e. your results from the EWs. In the PERFORM project we obtained: ✓ UK case study: Health, demographic change and wellbeing ✓ French case study: Secure societies, freedom and security ✓ Spanish case study: Climate action, environment, resource efficiency and raw materials

The EU Societal Challenges refer to worldwide problems but are very broad and general. To make students notice that with a STEM job is possible to face big challenges our advice is to show specific and particular cases during PERSEIA. This helps the audience to better understand the concepts. Some examples used by SMS about EU- Societal Challenge “Health, demographic change and wellbeing” are:

With a STEM job you can solve great challenges of humanity, such as curing incurable diseases like cancer or malaria.

We are currently researching on the possibility of using CRISPR as a tool to modify genes that, when mutated, produce diseases like muscular dystrophies, lung cancer ... even diabetes or colour blindness could be treated!

An example related to "Europe in a changing world - inclusive, innovative and reflective societies" used by TRACES is:

Science at the service of new technologies allows us to create a fully connected communication society. With social media we can know about Brad Pitt's latest diarrheal… even before it happens. But science and new technologies serve for much more. They make our society a more inclusive place, everyone has a voice. For example, do you know Molina de Aragón, province of Guadalajara? Of course not, because it's a shitty town, where nothing happens. But now it even has Facebook.

And a third example related to "Climate action, environment, resource efficiency and raw materials" used by SMS:

Performer gets volunteer to push the plunger down on a large bore syringe containing some peat blocks and above the blocks some dirty water, audience notes how slowly the water drips out of the syringe as it is filtered by the peat.

Performer and volunteer now repeat the syringe demo, but with a syringe filled only with clean water. As the volunteer pushes down on the plunger, the busker so angles the syringe so that it sprays the water over the audience.

Performer.- See what happens when we don't have peat to slow our water down! It shoots into our drains and rivers so fast that we get lots more. We have to look after peat and similar environments so they can look after us! Any you know who gathers the evidence for this, to go to governments and help them put policies in place to help the environment, mostly its scientists, fighting to save our planet, like

the organisation called “bioversity”.

Table 7.5: Guidelines for addressing gender issues in science

Guidelines addressing Topic 5: GENDER ISSUES IN SCIENCE
To give women scientists as role models: ✓ Give special mention to female physicists, engineers and computational scientists.
To give special attention to girls in engineering: ✓ To strengthen girls' self-confidence to pursue engineer/maths studies. ✓ To highlight the social projection of engineering.
To highlight that STEM-Jobs are not gendered: ✓ The features that define STEM jobs (curious, motivated, hard-working…) are gendered neutral. ✓ Boys can be Astronomer/Veterinary. ✓ Girls can be Inventor/Engineer.

In order to address gender issues it is very important that both men and women participate in the PERSEIA as performers. Moreover, to break related stereotypes, women should perform with a principal role in the PERSEIA.

Sometimes, to overcome our fears and dare to do things we need external role models. We look at other people who have done amazing things and try to follow their example. In that sense, girls may have a hard time choosing careers in science and technology, since the fantastic female models that exist are not given the relevance they deserve. Therefore, it is crucial that PERSEIAs include female scientific models and highlight their contribution to science and technology.

In TBVT PERSEIA great discoveries made by women are highlighted. They talk about female scientists and, in addition, some jokes are made to help students remember their names:

A couple of years ago two scientists, Jennifer Doudna and Emmanuelle Charpentier, I call them Emma and Jenny, put together a technique that is already

revolutionizing the world: CRISPR / Cas9

For example, Hedy Lamarr ... don't you know Hedy Lamarr? She is "La Marr" *(in Spanish "la mar = very")* famous. Thanks to her today we have ... Wi-Fi! What would we do without Wi-Fi? Talk to each others? Come on! Thanks Hedy, you've been la-marr useful to humanity.

Also, during TBVT PERSEIA the female performer talks about her own experiences related to STEM careers and jobs, showing that STEM careers are not gendered by highlighting as a feasible role model their own personal experience:

Male performer.- It is true that with a scientific, technological or math career you can get to work on unimaginable things.

Female performer.- When I was 14 I always wanted to be a pilot, and design and build aircrafts.

Male performer.-Then you have to study a lot of physics, mathematics and engineering.

Female performer.- I already liked design video games 15 years ago.

Male performer.- *A*nd without math, calculation or programming do not go beyond the Tetris.

Female performer.- At 16 I was inclined to play sports because I love to play football.

Male performer.- Biology, chemistry, nutrition, even mathematics to calculate game statistics...

Female performer.- And in the end I became a Genetic Engineer. Studying a lot of biology, chemistry and physics.

[Woman talking] When I was a teenager I decided to become a genetic engineer. Jurassic Park dictated my future! To do so, I had to study very hard not only biology, but also physics and maths.

It is also important, if you are thinking to use volunteers from the

audience to follow the guideline from SMS: take always the same number of female and male volunteers.

A second action implemented by TBVT is to use a YouTube video that highlights the role of important women in mathematics during the history of humanity (you can see it here).

Out of the assessment of the PERSEIA, we learned that only mentioning the name of some women scientists during the show may be a good starting point to change students' perceptions on gender issues, but is not enough. We do believe more effort needs to be put on showing current scientists as role models and real barriers for girls in STEM.

With the objective of highlighting that STEM jobs are not gendered, TRACES performers represented a dialogue between a father and her daughter in their PERSEIA. They represented a sketch in which both of them are doing the 3 more positive STEM-jobs selected by students in the EWs: business woman/man, pilot and architect. As good clowns, they amplify and caricature the main positive features of these jobs. And at the end of this dialogue, the father explains to his daughter that she will need mathematics and sciences together, if she wants to choose one of these 3 jobs. As the daughter and the father play these different jobs, it really shows that a man or a woman can make these jobs. You can consult the complete script of the TRACES clown PERSEIA in Annex 2.

Table 7.6: General Recommendations

GR: General recommendations
To foster students' interaction: ✓ To invite students to make questions or to give their opinion during/after the PERSEIA.
To use Social Networks: ✓ PERFORM has Twitter and Instagram accounts. Use them to generate dialogue between performers and students. ✓ Social network dialogue can take place during PERSEIA or promoted during PERSEIA to be made afterwards.

To use videos:

- ✓ To show a short video (3 to 5 minutes) talking about a scientific topic.
- ✓ Use the video to reinforce the scientific information or RRI values given in the PERSEIA.

A good way to increase the interactivity of the PERSEIA is promoting students to ask questions about the scientific facts and concepts exposed during the show, but also invite them to ask about any doubts they may have related to the scientific careers, enabling an open question turn at the end of the show.

To promote the participation of the students in the open question turn, a good option is to enable a hashtag and allow them to use their mobile phones to send questions during the show using Twitter, taking into account specific school rules. At the end of the PERSEIA the questions are read and answered.

One way to catch students' attention and driving them to the use of the hashtag is to generate a Twitter survey during the PERSEIA. In the case of TBVT, the hook used was related with genetic engineering:

And now that you know that we have a technology that allows us to do it, would you change your genes? We have a Twitter survey that you can answer.

Would you change your genes? #performstem

Do not

Yes

Only due to illness

Nowadays, young people are fascinated with social platforms, like Instagram. In the PERFORM project we took advantage of this. During the open question turn we took a *selfie* with the audience and uploaded to the PERFORM Instagram account. As long as students wanted to be tagged in the picture, they started a connection with PERFORM social networks beyond the PERSEIA delivery (see figure 7.3).

A

B

Figure 7.3 Pictures taken by SMS (A) and TBVT (B) for the Instagram account of PERFORM project.

The use of volunteers is a fantastic way to maintain students engaged with the PERSEIA. In the Science Busking case it's easy: busk experiments are always performed with the assistance of one (or more) volunteers from the audience.

The use of volunteers in clown shows is also widely known. TRACES uses this tool in their PERSEIA by taking a volunteer from the public, tying him to a chair, removing his mobile phone and breaking it using a hammer. Actually, the phone is not destroyed, but the fact of including in the show not only a volunteer but also something as precious for adolescents as their phones, allows TRACES to capture their attention very intensely.

Finally, and always with the objective of engaging young students with science, it is possible to break all the laws of the stand-up comedy and include volunteers in the monologues. TBVT does more interactive PERSEIAs introducing in one of their scientific monologues an experiment: to light a fire using a bow, a rope, and a wood stick. The experiment is integrated into the scientific concepts showed during the monologue, and is performed by two volunteers from the audience recapturing the attention of the students (see figure 7.4).

Figure 7.4. TBVT performer with two volunteers

Now is your turn!

Let's transform your drama-based activity into a PERSEIA. Remember:

- Read documents and watch videos about the topics that humanise science and the values embedded in the RRI
- Deliver the EWs and analyse the collected data
- Extract your own guidelines, decide what you want to address
- Adapt your performance-based activity into a PERSEIA
- Let's PERFORM!

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ANNEX 1: EXPLORATORY WORKSHOPS DATA ANALYSIS

For data analysis two approaches have been used depending on the nature of each EW following Hsieh & Shannon (2005):

- Summative content analysis: 'Priorities for the world', 'gender' and 'STEM careers' EW had a very standardized guide for their development in the classroom, so they provided a type of outcome more suitable for their quantitative exploitation. In these EW students were asked to sort some topics, organize preferences, or assign values to particular categories.

- Directed content analysis: 'Science and me', 'stereotypes' and 'ethics' exploratory workshops produced more discursive outcomes suitable for a more qualitative approach. Hickey & Kipping (1996) provided by the amount of existing prior literature.

EW1- STEM market: The role of entrepreneurial and multidisciplinary research careers in labour market

For this topic we carried out four EW with the characteristics in table 3.2.

Table A1.1: Number of students per EW1 in each case.

	UK	France	Spain	TOTAL
Boys	9	17	11	**37**
Girls	6	18	9	**33**
Total	15	35	20	**70**

This EW also aimed to understand if young people associated STEM careers with future ‘good’ jobs. With this objective in mind participants were proposed, in first place, to discuss in small groups what could be their ideal jobs for the future. The jobs chosen by each group were written in the blackboard and, as a result, we obtained a final list with the five "best jobs ever" (see Table A1.2).

Table A1.2: "Best jobs ever" by country

Spain	**France I**		**UK**
Businessman	Architect	Military serviceman	Teacher
Airline pilot	Doctor	Architect	Doctor
Football player	Wedding planner	Police officer	Engineer
Architect	Football player	Airline pilot	Spy
Politician / Model	Businessman	Doctor	Lawyer

As can be seen, doctor and architect, followed by business man, football player and airline pilot were the most cited ones. None of the students mentioned specifically a “scientist” but if we pay attention to the specific disciplines included in STEM careers (Chemistry, Computer Science, Engineering, Environmental Science, Geosciences, Life Sciences, Mathematics and Physics/ Astronomy) we found that two of the jobs cited by students are related specifically to one of those fields (engineer and doctor). Indeed, the content of other professions reported here are (or could be) also related to science in a wide sense (such as teacher or airline pilot) but students were not able to detect this implicit relation in further discussion.

After examining which was the "best jobs ever", this EW looked over which characteristics students usually associate with the former "best jobs ever" (figure A1.1). Students usually relate best jobs with earning money, travelling and a high degree of autonomy, which is proof of the complex intrinsic and extrinsic motivations that operate students’ preferences. They seek social relevance through their “best jobs ever” but this concept changes along with the different cultural contexts. For example, in the case of Spain this relevance is related to business and

media repercussion while in the case of United Kingdom it is related to teaching.

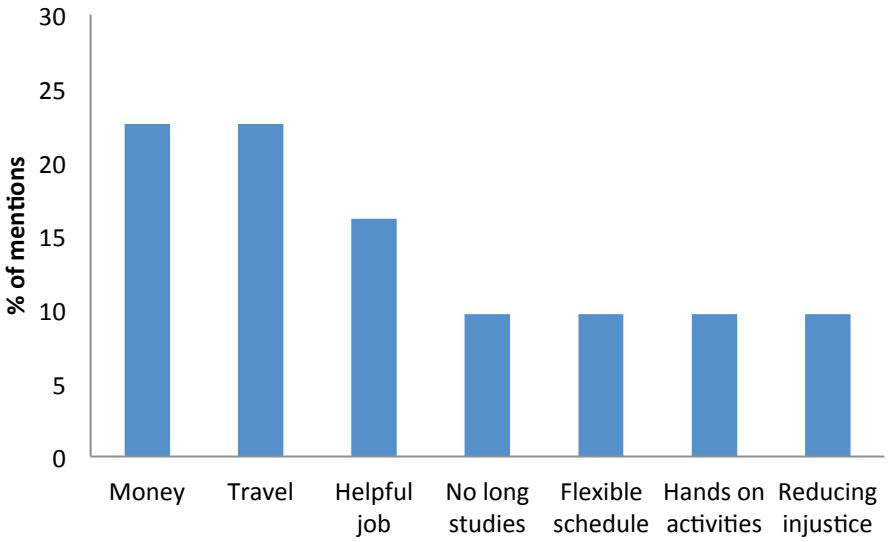


Figure A1.1: Features that student relate to their "best jobs ever". Total results

Most of these characteristics (travel, helpful job, flexible schedule) are also applicable to some STEM jobs but they do not identify this connection. On the other hand, the requirement that ideal work does not entail long studies -related with a low level of effort and short-term goals- seem to collide completely with the particularities of the research career. This is particularly evident in the case of Spain and France.

3.3 EW2- Stereo-science-types: Science-related stereotypes

For this topic we carried out four EW with characteristics shown in table A1.3:

Table A1.3: Number of students per EW2 in each case.

	UK	France	Spain	TOTAL
Boys	13	0	22	**35**
Girls	10	8	28	**46**
Total	23	8	50	**81**

Data obtained from student comments were analysed through a directed content analysis (Hsieh & Shannon, 2005). In order to apply this analysis collected data were classified according to the four topics that facilitators proposed to students (see table A1.4).

Table A1.4: Dimensions and categories identified through the exploratory workshops (indicators and/or criteria previously identified in the literature review but with no mention in EWs are indicated with an asterisk)

Dimensions	Categories	Examples
Scientists at leisure	**Boring**	*"Scientists work during the weekend and go out very little" (S_Spain)*
	Bad material conditions	*"In laboratories there is a boss in charge, and this usually has very little money to research and pay their workers" (S_Spain)*
	Freaky, nerd	"Scientists are nerds, people unsocial" (S_Spain)
	Social rejection	"In class he is a brainier who knows everything. Outside class he has social problems and classmates hit him" (S_Spain)
	Imaginative	*"Scientists are able to invent things tosolve their own problems"*(S_Spain)

	External recognition	*Manager recognises scientist and gets autograph (in the role play)*(S_UK)
Future scientist at school	**Freaky, nerd**	*"They can only speak with scientific words"* (S_Spain)
	Social rejection	*"Outside class he has social problems and classmates hit him"*(S_Spain)
Scientific professional projections	**Knowledge motivation**	*"To be a scientist you must be motivated by scientific phenomena"*(S_Spain)
	Long term goal	*"It is too much time to spend studying"*(S_Spain)
	Self-confidence is necessary	*"To become a scientist you must have great self-confidence"* (S_Spain)
Scientist´ personal features	**Unable of social relations**	*"Girlfriends ask not to talk about work or science but the scientist forgets"* (S_UK)
	Mad scientist*	"They can't stop working, even when they are supposed to take a break or have some fun" (S_FR)

EW3- Life recreation (LR): Ethical issues in scientific research

For this topic we carried on five EW with characteristics shown in table A1.5:

Table A1.5: Number of students per EW in each case

	UK	France	Spain	TOTAL
Boys	7	7	12	**26**
Girls	13	15	19	**47**
Total	20	22	31	**73**

Data obtained from students' comments were analysed through a directed content analysis (Hsieh & Shannon, 2005). Data were classified into dimensions and categories shown in table A1.6.

Table A1.6. Dimensions and categories identified through the exploratory workshops (indicators and/or criteria previously identified in the literature review but with no mention in EWs are indicated with an asterisk)

Dimensions	Categories	Subcategories	Examples
Research integrity and good research practice*	Gap between codified rules and scientific practice		
	Accountability with respect to research integrity		
	Neutrality, conflict of interest and bias		
Research ethics for the protection of the objects of research	Animal awareness		It was fair to kill a pig to save a human? (LR_UK)

			Custom sized dogs would be sad and that was unfair (LR_UK)
	Environmental awareness		"If we need to pollute to produce these bacteria, then it is not a good option" LR_Fance
	Human awareness *		
Societal relevance and ethical acceptability of R& I outcomes	Religion awareness		"People might not want a pigs heart (Muslims)" (LR_UK)
	Public participation awareness, public engagement		"It is compulsory to bear in mind the opinion of the citizens" (LR_Spain)
	"Bio" issues	Genetic diagnosis	"Would only make us more scared of what would kill us" (LR_France)
		Cloning	"You have to think about the feelings of the clone"

			(LR_Spain)
		Brake the natural balance	"We must revive extinct species only if the extinction was fault of human been. In other way would be unethical" (LR_Spain)
		GMOs*	
	Robotic issues	Loss of employment	"Create humans without disease is the most important, but would leave the doctors unemployed" (LR_Spain)
		Risk of humanizing	"they could take over the world" (LR_Spain)
	TICs issues *	Technological dependence	
		Loss of privacy	
		Data security	
	Security *		
	Social issues*	Social justice/inclusion	
		Education	

		Gender	

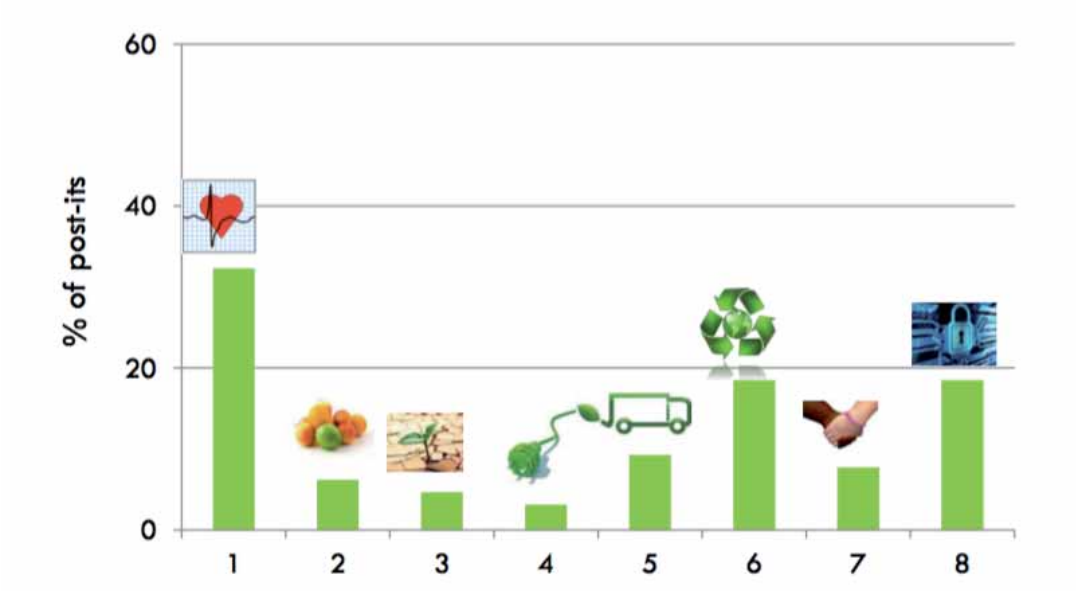
EW4- Our priorities for the World: Relevant scientific topics related to current EU societal challenges

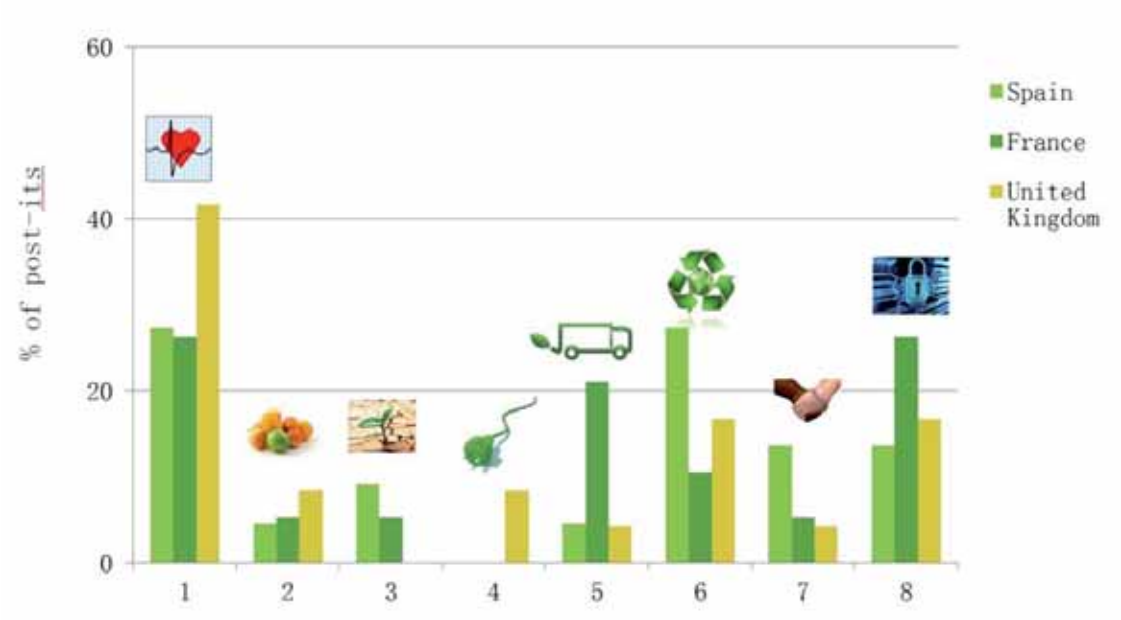
For this topic we carried on five EW with characteristics shown in table A1.6:

Table A1.6: Number of students per EW4 in each case

	UK	France	Spain	TOTAL
Boys	2	6	14	**22**
Girls	6	11	15	**32**
Total	8	17	29	**54**

For data analysis the number of proposed challenges expressed by students and assigned to each European societal challenge was counted (in total, figure A1.2). Aggregated results show that most of the students' proposals, in the three case studies, were related to health, demographic change and wellbeing, followed by climate and environmental actions. Secure societies, freedom and security was the third challenge with the highest number of proposals.





Figures A1.2 and 3.4: Relation of projects and societal challenges overall (3.3) and per country (3.4). Challenges legend:1: Health, demographic change and wellbeing, 2: Food security, 3: Sustainable agriculture and the bioeconomy, 4: Secure, clean and efficient energy. 5: Smart, green and integrated transport, 6: Climate action and environment, 7: Inclusive, innovative and reflective societies, 8: Secure societies, freedom and security.

EW5- Science and me: Two-way dialogue between scientists and the society

For this topic we carried on five EW with characteristics shown in table A1.7:

TableA1.7: Number of students per EW5 in each case

	UK	France	Spain	TOTAL
Boys	9	7	6	**22**
Girls	16	7	6	**29**
Total	25	14	12	**51**

Data analysis was based on students' final discussion about the result of their programmes and notes taken by facilitators about their role playing performances. In order to apply a directed content analysis (Hsieh & Shannon, 2005) students'

comments were classified into the dimensions and categories defined in table A1.8.

Table A1.8. Dimensions and categories identified through the EW (indicators and/or criteria previously identified in the literature review but with no mention in EWs are indicated with an asterisk)

Dimensions	Categories	Subcategories	Examples
Interest	Professional questions		*"What are you Researchingabout?"* (SM_SP)
	Pragmatic questions		"What is the use of your job?" (SM_FR)
	Personal questions related to their profession		*"What do you like/ don't like in your job?" (SM_FR)*
	Scientific literacy questions		"How did they invent the balloon?" (SM_UK1)
Closeness	Scientist identification	Scientists	
		Family/friends	
		Teacher	
		None	
Sources of scientific information	Internet		
	Science museums		
	Teacher		
	Scientific Literature		
	TV		

Figure A1.3 gathers the answers given by students in all three cases. It represents discourses trends in a simplified and visual manner.

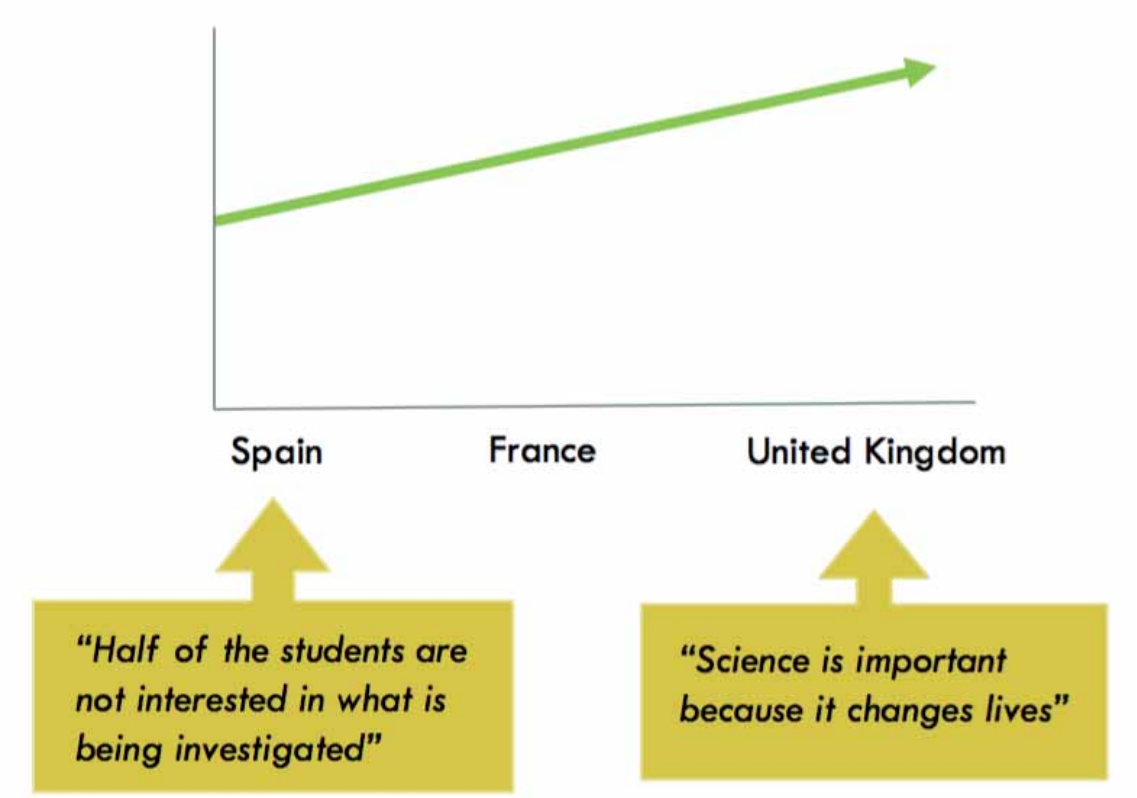


Figure A1.3: Discourse tendencies in Spain, France and UK regarding students' interest in science and scientist work.

Between those with lower level of interest in science there were clear differences regarding the importance of different scientific areas (Figure A1.4). For the Spanish case study students' health, anthropology and technology seem to be more important than other scientific issues, while for French students health and environment were the key topics. Finally, for UK students, those showing a higher interest in researchers work, all scientific areas were equally important.

Finally, figure A1.5 shows the sources of information that students consider relevant when looking for scientific information.

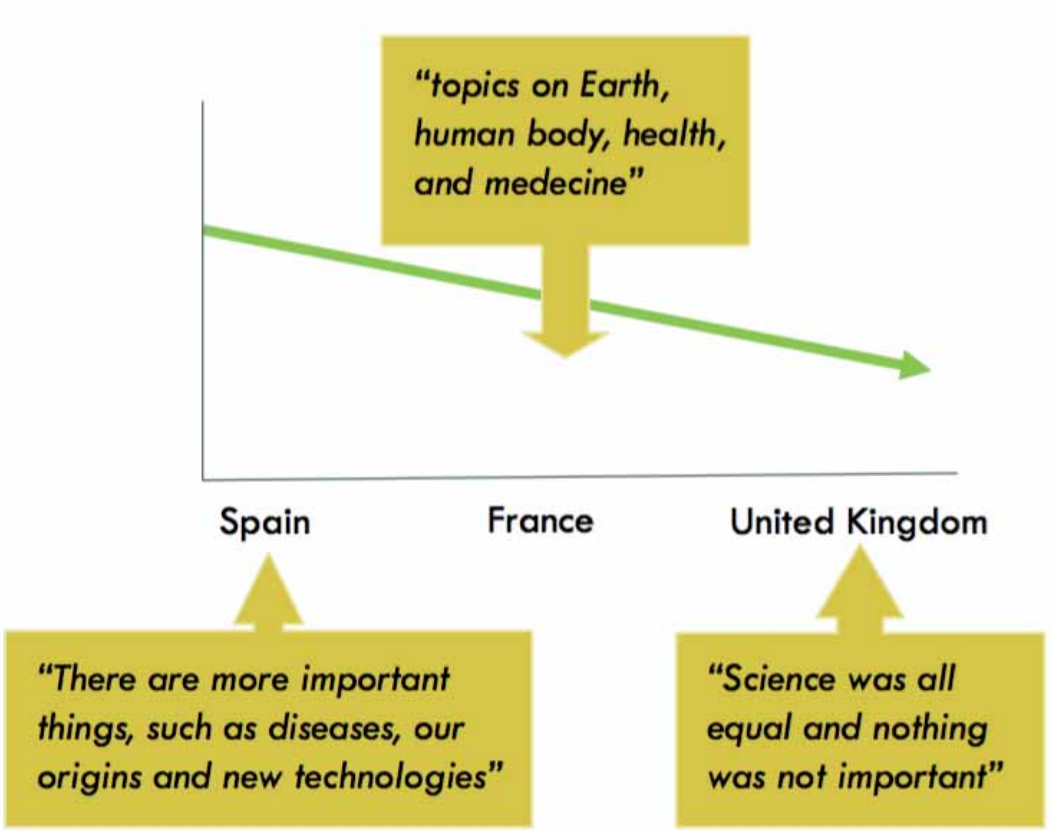


Figure A1.4: Discourse tendencies regarding priority thematic areas in science per country.

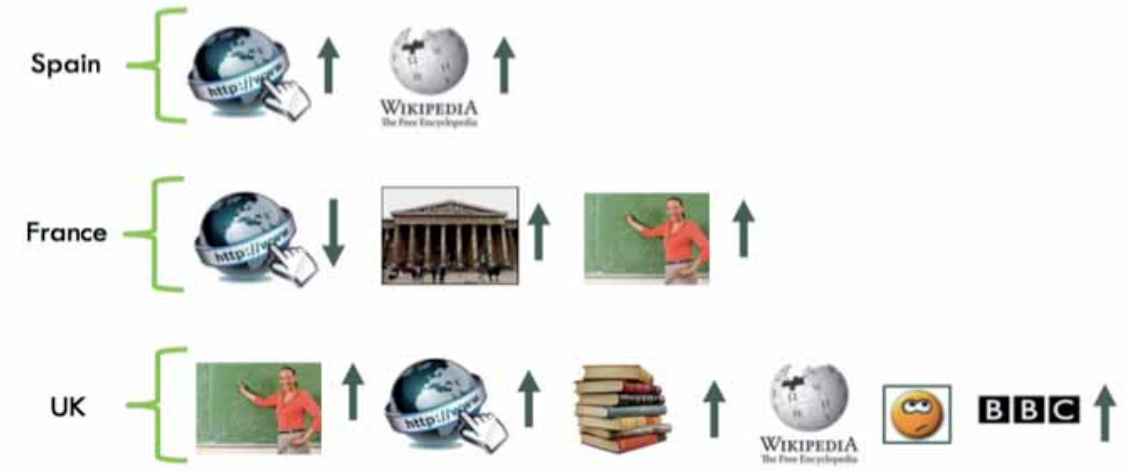


Figure A1.5: Sources of information and confidence level per country

EW6- Science and me: Two-way dialogue between scientists and the society

For this topic we carried on five EW with characteristics shown in table A1.9:

Table A1.9: Number of students per EW6 in each case

	UK	France	Spain	TOTAL
Boys	20	9	17	**46**
Girls	15	9	22	**46**
Total	35	18	39	**92**

Findings from this EW allowed for finding out whether students perceived that certain STEM jobs were gender stereotyped and the reasons why. As a result of their interventions we obtained a general portrait of some STEM careers (see figure A1.6) and particular portraits of each profession (see figure A1.7).

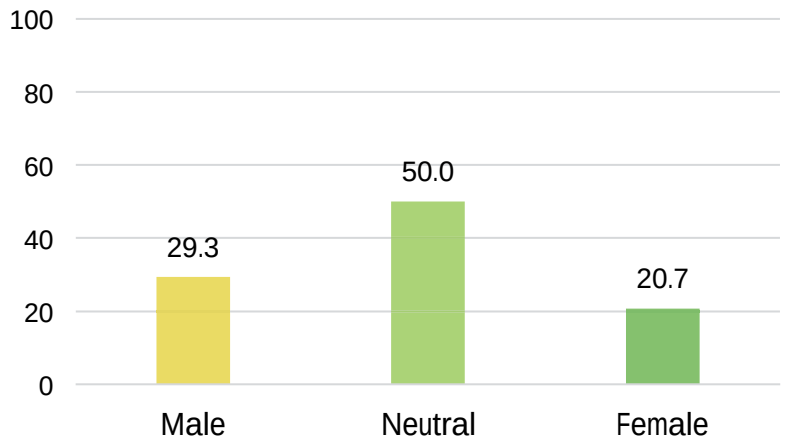


Figure A1.6. STEM jobs descriptions

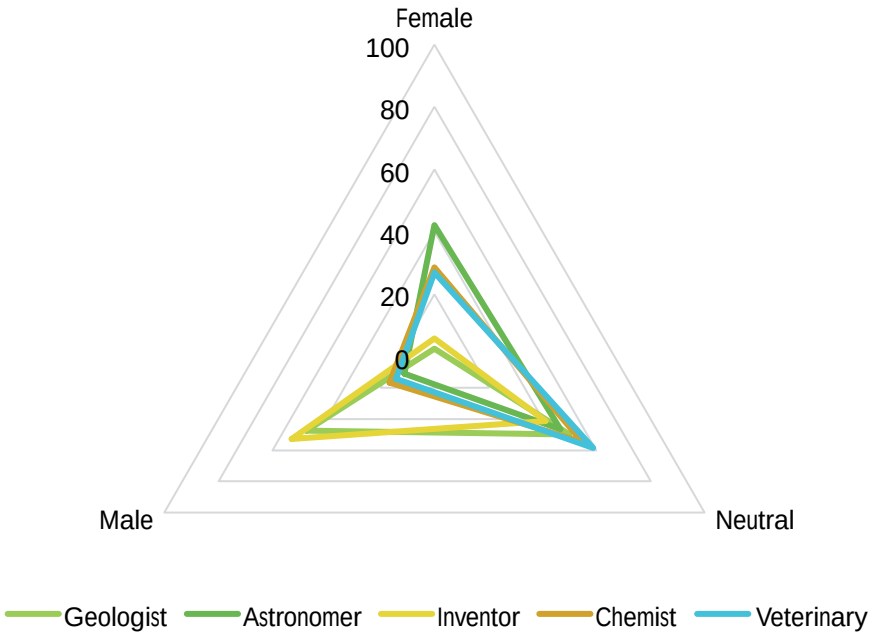


Figure A1.7. STEM descriptions by job

We did not find significant differences between case studies. It is only worth mentioning the case of some professions strongly gender-stereotyped, such as the case of chemist career in Spain (figure A1.8) which was strongly masculinized, while in UK (figure A1.9) astronomy was particularly feminized. In the case of the French case study there was not enough sample to make a separate analysis.

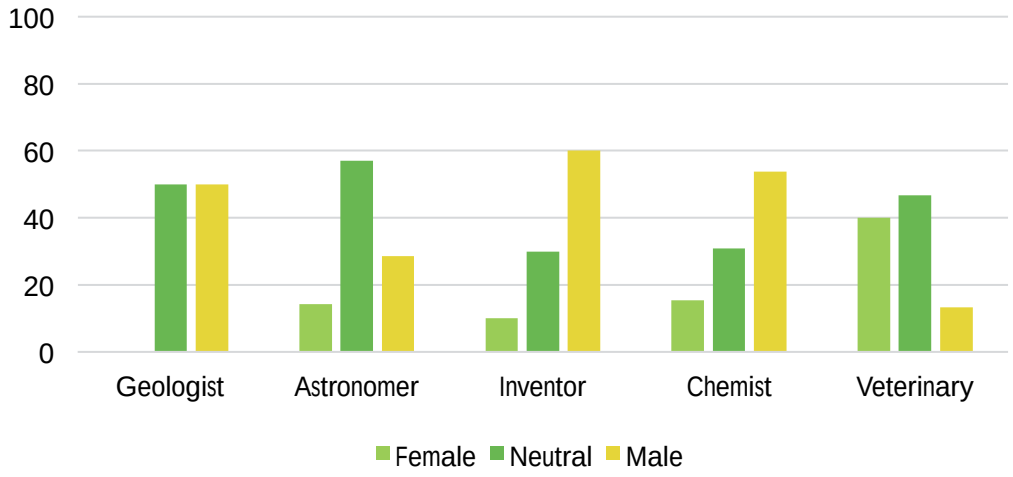


Figure A1.8. STEM jobs description by country (Spain)

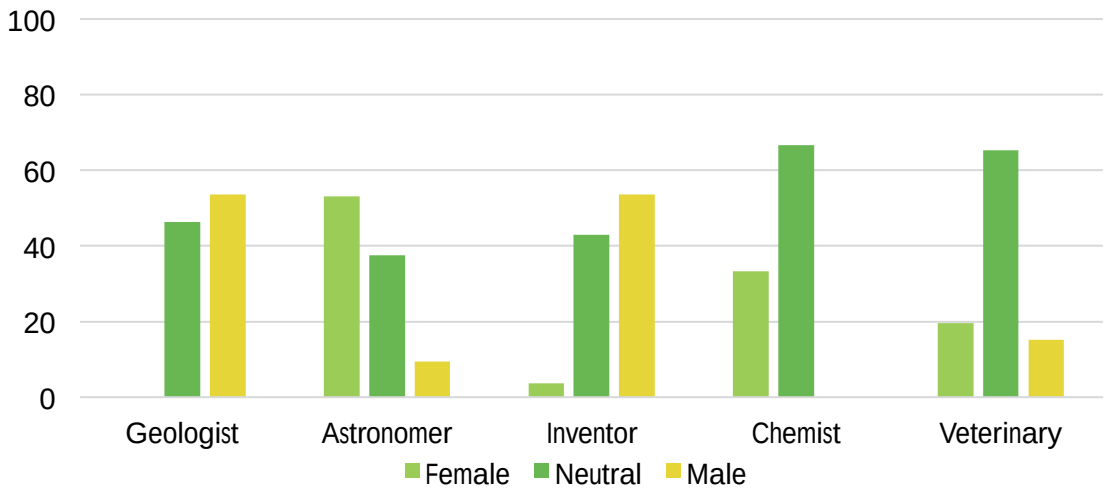


Figure 3.12:STEM Jobs description by country (UK)

ANNEX 2: SCRIPTS ANALYSIS

TBVT PERSEIA Script

This script is written in Spanish and the extracts highlighted in green are the ones adapted after EWs and are explained in notes in English in the text.

1- VIDEO Locos por Ciencia

EW1: This video shows up to four possible research fields: physics, biology, chemistry and biotechnology applied to renewable energy.

General recommendations: to show a video.

2- ORIOL PRESENTADOR

Bueno, muchas gracias por esos aplausos, merecidos, cierto es. La verdad es que con un recibimiento así uno se siente a gusto, arropado, querido… me siento tan bien, que voy a haceros una confesión: soy científico. Sí, efectivamente, todos los miembros de Big Van, Van con "V", de furgoneta, todas las personas que vamos a salir hoy aquí al escenario, somos científicos. Es importante aclarar esto porque a los científicos se nos han asociado siempre mogollón de estereotipos y prejuicios… que si somos aburridos, que si no tenemos vida social porque siempre estamos trabajando en nuestros laboratorios, que nunca desconectamosy hablamos raro… ¡Pues todo eso es falso!

EW2: We break negative stereotypes by relating the stereotypes identified during Exploratory Workshops and saying that are false.

Bueno, todo, todo… no. Hay algo que sí es cierto: ¡somos unos frikis! Yo soy muy friki, el resto de mis compañeros que van a salir aquí, lo vais a flipar…Seguro que también hay frikis aquí… y empollones… bueno yo fui empollón, y eso es bien. Hoy traemos aquí

un mensaje de positivismo: Frikis y empollones de la sala: ¡Estamos con vosotros! ¡UN FUERTE APLAUSO, claro que sí, para el empollonismo frikero!

EW2: We break one negative stereotype (be Nerd) by saying that is a GOOD THING and we ask for a big applause to Nerds. We highlight positive aspects of being a Nerd using jokes and humour.

No tiene nada de malo saberse el nombre, las identidades secretas y las propiedades físico-químicas de los poderes de todos los vengadores y los X-men… y no saber quién es el Justin Viewer ese… en Wikipedia pone que es cantante…

No tiene nada de malo saberse el número atómico de todos los elementos de la tabla periódica, por orden, y que te pregunten por el pasillo "¿el boro?" y tú contestas "el 5", y quedas como Mendelev. Y no tener ni idea de lo que es hacerse un "selfie", que como era una cosa que se la hacia uno solo y en el baño, yo al principio creí que era otra cosa… *<hacer gesto de masturbación con la mano, no muy evidente>,* luego me dijeron que se hacía con un palo y dije que asco… pero no, resulta que es una autofoto de toda la vida…

Pero claro, son tantas cosas que uno anda desorientado. Y es que es así, en el instituto yo estaba más perdido que Charmander en el desierto del Sahara… "¿qué quemo, qué quemo? Y es que es una época de elecciones, hay que elegir y hay un montón de opciones. Puedes hacer un ciclo formativo, ponerte a currar o ir a la universidad. ¿Qué opción eliges? ¿Cuál es la buena? Lo más importante es hacer lo que más te gusta. Yo en la prepa me pregunté a mi mismo… ¿Orilo, qué es lo que más te gusta?

GR: Through the personal experience of the presenter students are shown that when choosing a STEM career is important to take into account the human and emotional factor, and it is important to choose the studies that motivate them, which they like.

Y me di cuenta de que lo que más me apasionaba era controlar la liberación masiva de energía en cortos periodos de tiempo debido a la reorganización molecular… hacer explotar cosas *(poner cara de loco)* ¡y me metí a química! Y fue un acierto, porque como elegí lo que más me gustaba, al llegar a la uni me encontré gente como yo, descubrí que no estaba solo, había más gente que también canta canciones de Ilenia en la ducha, que también moja el sándwich de jamón y queso en el zumo de melocotón, que también tiene un pijama de Finn el Humano.

Pero si hasta se foll… se empolla en grupo en la biblioteca, haces amigos, sales de fiesta, estudias en otros países… Esa fue una de las mejores cosas que me dio la uni, viajar.

EW1: Two of the positive aspects that students comment on the EW (travelling and learning languages) are highlighted using jokes and relating them with a European programme to travel during university called ERASMUS programme.

Que para viajar no tienes por qué ir a la Uni, pero la uni te lo pone a huevo.

Yo por ejemplo me fui de Erasmus a Londres, qué ciudad, que smog, que puentes, que gente más fea (*todo con cara de felicidad*). Y además de empollar y sacarme física-quimica III… conocí un montón de gente, y claro, tuve que aprender un idioma nuevo ¡el inglés! Ahora yo tengo nivel alto de inglés, voy por ahí me preguntan ¿Cómo se dice mirar? look. Haga una frase: Look, yo soy tu padre.

En la Uni aprendes mogollón de cosas que te interesan de verdad, yo en química, aprendí a hacer mis propios experimentos. En ingeniería industrial, aprenden a diseñar sus propias máquinas, en económicas aprenden a imprimir billetes de 500€ en su casas. Te vuelves un mago de nivel 21, porque te conviertes en la persona que más sabe sobre transmisión de datos, genética o comunicación. Eres imparable. Hacer una carrera STEM, pues eso, de ciencia, tecnología, ingeniería o mates te da muchas cosas buenas:

- Te vuelves creativo e imaginativo porque tienes que crear nuevos aparatos, nuevas máquinas.

EW2: It highlights the positive stereotypes of scientists, associating them with the EU-Societal Challenges solution (EW4). It gives an epic utility to the scientific being: they solve the problems of humanity (GR).

Como los ingenieros que hicieron esos láseres para descubrir las ondas gravitacionales, que revolucionaron el mundo de la física, o esos dos chavales, que inventaron el pelador de plátanos automático, que revolucionaron el mundo de…

- Bueno, con una carrera STEM puedes solucionar los grandes retos de la humanidad, como curar enfermedades incurables tipo el cáncer o la malaria, conocéis la malaria, una enfermedad que es muy maaaaala, o te mata o te deja gilipollas… yo la he pasado dos veces.
-

EW4: EU Societal Challenges. To use the EU Societal Challenges that students have considered of interest as a hook (health and wellbeing in Spain) to highlight that with a STEM career you can face the main challenges of humanity, like curing important diseases (Cancer, Malaria)

- Eso sí, se trata de un trabajo a largo plazo, que te puede volver un poco Nerd o Nerda, pero que te da el reconocimiento de la gente, de la sociedad. Cuando algo queda científicamente demostrado, la gente se lo cree, hasta que se demuestre lo contrario. Está científicamente demostrado que el ser humano evolucionó de los primates, que la Tierra gira alrededor del Sol o que si tiras un cacahuete a una piscina deja de ser un fruto seco.

GR: It is very important to rate the jokes. Do not stop after the jokes waiting for the laughter. The performer must move on. The performer should only stop if the laughter is so loud that he is not heard. In that case, he stops, thanks, expects the public to return to him, and continues.

Pues bien, esto es lo que hemos venido a hacer hoy aquí. Los científicos de BigVan, van con "V", de furgoneta, os vamos a presentar, en forma de monólogos científicos, lo que hemos aprendido durante nuestra carrera científica. Eso sí, antes de empezar voy a daros unas indicaciones muy claras, un protocolo a seguir, los científicos somos mucho de protocolos, para que nadie ni "nadia" salga herido en este espectáculo teatral de cinco horas de duración.

El protocolo es sobre las risas. Nosotros somos científicos. No somos actores, no somos monologuistas por pura definición… no somos graciosos. Así que si notáis, que yo, o cualquiera de mis compañeros intenta hacer algo, con la más mínima intención de haceros reír… vosotros os reís… aunque sea forzando. Vuestra sinceridad nos importa un pimiento. Además, las risas son buenas, porque liberan endorfinas, encefalinas… toda una serie de hormonas que podéis utilizar para reír más, para amar… y para otras cosas.

Además, lo que nosotros hacemos es humor inteligente… vamos, que si no te ríes parece que no lo has pillado. Te viene esa vocecilla interior, que todos sabemos que es "EL SUPER" de Gran Hermano, y te dice: ¡pero ríete empanao, que tolmundo lo ha pillao menos tú! Y tú te ríes y quedas como un intelectual más.

Sí, todo el mundo cómodo y preparado. Voy a dar paso al primer científico que va a venir hoy aquí: - *se presenta al científico*-

3- HELENA GENÉTICA

Antes de comenzar con mi monólogo voy a hacer un mínimo test de nivel para ver en qué términos nos podemos hablar. Yo digo una frase y vosotros la completáis:

Qué pasa chavales, ¿todo bien, todo correcto?

(Público responde) - ¡Y yo que me alegro!

Pues de esto precisamente os quería hablar. Como bióloga que estudia la flora y la fauna me ha dado últimamente por estudiar a youtubers. Que vaya fauna hay por ahí. Y una siempre está dispuesta a encontrar a una nueva especie.

Pero igual que a mí a vosotros también os pasará que de vez en cuando os sale un video a traición, de esos que no andabais buscando pero os lo meten doblado. Y el otro día, sin comerlo ni beberlo, me saltó un video hablando de cómo hacer un homúnculo. ¿Lo habéis visto? Para los que no, yo os lo cuento. Os jodéis.

El video lo ha hecho un tío ruso que coge un huevo de gallina, le inyecta sus propios espermatozoides, lo incuba en el microondas… *(cambiando el tono)* lo incuba en el microondas… todo el mundo sabe que si metes un huevo en el microondas explota. Eso o te pillas el otro con la puerta.

Bueno, después sale un hombrecillo gusanoide chiquitín y que se mueve. Se creen que somos idiotas, ¿verdad? Pues el video tiene 10 millones de visualizaciones. La evolución nos está llevando a un abismo intelectual sin límites. Pero si es imposible que haya fecundación cruzada entre especies. Es un principio básico de la biología: un individuo de una especie sólo puede fecundar a un individuo de la misma especie: humano con humano, gallináceo con gallináceo… es una de las razones por las que el mundo no está lleno de hombres cabra.

Y es que una cosa que a mí me da mucha rabia son esos videos, o esa gente, que dicen hechos de supuestos hechos científicos pero que son mentira. Eso se llama pseudociencia. Aunque a mí me gusta más llamarlo anticiencia o puticiencia. Seguro que muchos os sonarán:

¿Sabes que si tomas bicarbonato curas el cáncer? Hala, venga. Miles de laboratorios en el mundo tratando de descubrir un tratamiento para una de las enfermedades más complejas que existen y resulta que podríamos evitárnoslo con un poquito de sal de frutas. Ya os digo yo que nos toman por tontos. La gente que dice tales tonterías no han pisado un laboratorio en su vida. Los hechos científicos son los que salen de los laboratorios, donde hay una comunidad enorme de científicos evaluando si podemos demostrar o no científicamente algo.

EW5: To make non-scientific statements as "cancer heals by taking bicarbonate". Ridiculing this kind of statements and explaining that only the facts that are scientifically proven in laboratories are a reliable source of information.

Uy, y otra muy buena. ¿Sabes que sólo utilizamos un 10 por ciento del cerebro? A ti se te nota, guapo. ¡Pero cómo vamos a usar sólo un diez por ciento! No hombre, lo usamos todo. Es verdad que este tipo de afirmaciones salen reforzadas de películas como Lucy, esa peli en la que Scarlett Johansson, a medida que va utilizando cada vez más su capacidad cerebral, es capaz de ver las ondas electromagnéticas, convertirse en un polvo azul cristalino y viajar al pasado hasta darle la mano a un *Australopithecus afarensis*. Llamadme rigurosa, pero con esta sucesión de hechos conviene no tomarse muy al pie de la letra lo que nos cuentan ahí.

Y hablando de pelis… en el top de las películas de anticiencia están las de superhéroes. Esas en las que te irradias con radiación gamma o rayos X y adquieres superpoderes. Esto no lo hagáis en casa. Meterse en un reactor nuclear para exponerse radiaciones no te hace un superhéroe gordo y verde. Como mucho acabarías muerto.

Estas pelis además intentan justificarse "científicamente" hablando de mutaciones. Mutaciones que nos hacen mutantes. Las radiaciones mutarían tu ADN, es decir, cambiarían las letras, los nucleótidos en tu ADN para darte poderes especiales. Las mutaciones están sobrevaloradas. Miraos los unos a los otros. En serio, miraos… los hay más feos pero esto siempre pasa. Aquí todos somos mutantes, si bien a unos se les nota más que a otros. Mutantes todos, *(coger carrerilla y decir de seguido)* los rubios los morenos, los de ojos azules, los de ojos negros, los altos, bajos, intolerantes a la lactosa, tolerantes, los diabéticos y los que no lo son, pecosos, daltónicos, miopes y los que no necesitan gafas… TO-DOS.

Porque ser mutante no significa otra cosa que tener pequeñas variaciones en nuestro ADN que nos hacen distintos del resto. Sin mutaciones esto sería un mundo de clones, y eso sería un aburrimiento total. Tú y siete mil millones como tú. Qué peste.

Poniéndonos rigurosos, podemos argumentar que los superhéroes son transgénicos. Os suena esto de transgénicos, ¿verdad? Claro, por el tema de los alimentos transgénicos que nos comemos. El maíz, la soja, el tomate…

Un transgénico no es más que un organismo con un gen de otro organismo, de otra especie, de otro, vaya. Y ese gen que viene de otro es un transgen, un gen que no es tuyo. Y ese gen le dará unas características especiales.

Imaginad que tenéis el ADN de un tomate y decidís ponerle un gen que aumente la rigidez de su pared celular para conseguir que aguante turgente más tiempo, que no se reviente. Vaya mierda de superpoder. Me imagino en la Marvel: Tío, tengo el superhéroe definitivo. Un tomate que no se revienta…

Afortunadamente los superhéroes que tenemos, aunque no son reales, molan mucho más.

Spiderman. Ahí lo que necesitamos es el ADN de un señor al que le introducimos genes, transgenes, de otra especie. La araña. Esto le confiere su sentido arácnido y la agilidad de un artrópodo para poder saltar de un edifico a otro.

Lobezno: Tenemos el ADN de otro señor y le introducimos genes de… ¡Lagartija! Pero llamarlo “Lagartijezno” no vende nada. Porque el superpoder de lobezno es el de regenerar los tejidos rápidamente. ¿Alguna vez le habéis cortado la cola a una lagartija? Qué crueles sois… lo que pasa ahí es que la lagartija es capaz de regenerar la cola. Lo mismo le pasa a lobezno. Con todos los tejidos, no sólo con la cola.

Aunque esto de cambiarse los genes suena a ciencia ficción, ¿verdad? No exactamente. Existe una técnica capaz de cambiar los genes en nuestras células. Se llama CRISPR. No crispis, que yo cuando escuché el nombre desayunaba con miedo. A ver si esto me va a cambiar el ADN y me voy a volver roja y turgente.

Hace un par de años dos científicas, Jennifer Doudna y Emmanuelle Charpentier, la Emma y la Jeny, pusieron a punto una técnica que ya está revolucionando el mundo: CRISPR/Cas9, en la que esta proteína es capaz de actuar como una pequeña tijera y cortar genes en nuestro ADN, los genes que nosotros le digamos, e incluso reemplazarlos por otros. Cortar y pegar, control C control V.

EW5: include examples of current scientists

EW6. Gender. To show actual/important women scientists as role models.

Use a joke with the names to help students to remember the names of the scientists.

¿Y cómo funciona? Fácil. Lo primero que tienes que encontrar es a alguien que sea capaz de pincharte una inyección sin reventarte el brazo. Así podrán inyectarte un vector que lleve esta tijera molecular a tus células, al núcleo, al ADN. Y allí cortar y reemplazar tus genes por otros.

Y ahora que sabéis que se puede hacer, ¿os cambiaríais los genes? Tenemos una encuesta en Twitter que podéis contestar.

¿Os cambiaríais los genes? #performstem

No

Sí

Sólo por enfermedad

GR: Use of social networks (whenever possible). To allow students to make questions or to give their opinion during the PERSEIA using a Twitter survey.

¿Os imagináis? Hombres con alas, cerdos con boca de dinosaurio… bueno, no exactamente. Los científicos no están aquí para jugar a crear nuevas especies, para jugar al " a ver qué pasa". No. Siguen unas normas éticas muy estrictas. Si en un laboratorio quieres cruzar genes de gallina y de humano para ver si de verdad sale un homúnculo de esos no te lo van a dejar hacer. Los científicos saben bien que no pueden jugar con los genes. Los vigila el súper de gran hermano, un comité internacional que impide que se hagan experimentos fuera de las normas éticas: curar enfermedades, sí. Jugar a crear nuevas cosas, no.

EW3: To highlight that scientists do not play to be God, as the research process is under ethical control.

Actualmente ya se están haciendo ensayos de laboratorio para cambiar genes enfermos por otros sanos: en distrofias musculares, cáncer de pulmón… ¡incluso se podría llegar a tratar la diabetes o el daltonismo!

EW4: To relate the last advances in medical research with the EU Societal Challenges that students have considered of interest as a hook (health and wellbeing in Spain)

Hay que seguir apoyando a la ciencia, entre otras cosas para impedir que estas técnicas caigan en manos sucias. Si no este mundo estaría lleno de homúnculos.

4- HELENA PRESENTADORA

Muchas gracias por esos aplausos. Antes de continuar con el espectáculo debo haceros una advertencia sobre los teléfonos… Esto es un espectáculo teatral, así que mantenedlos encendidos. Eso sí, ponedlos en modo silencio, no sea caso que os suene el politono de Bob Esponja y quedéis como el culo, porque así emiten más ondas electromagnéticas… los científicos, como buenos frikis que somos, nos alimentamos de ondas electromagnéticas. En los 90 nos alimentábamos de jugar a los tazos… y de chetos. Sabéis los chetos, la cosa esa que te deja los dedos naranja… en los 2000 nos alimentábamos juegos de la Play… 1, y de chetos, y ahora en los 2010 nos alimentamos de ondas electromagnéticas… y chetos. Cómo sería una guarrerida que nos lanzaseis chetos, pues nos lanzáis ondas electromagnéticas.

Además, los móviles tienen una segunda función. Y es que a nosotros, los científicos, nos encanta contestar a todas las preguntas que se nos hacen. Así que después de los monólogos, estaréis llenos de preguntas, sobre ciencia, sobre tecnología, o sobre la vida en general… nos las hacéis. Y tenéis dos vías. La primera, la de siempre, a mano alzada, como en clase, o la segunda, con el móvil, vía Twitter.

GR: We explain to students that at the end of the show there will be an open question turn. Students are allowed to use their mobile phones to make questions during the show using Twitter.

Porque hemos habilitado un hastag… en twitter… los científicos decimos mucho hastag… vamos por la calle, ei hastag, que pasa hastag… hastagluego… (entra diapositiva HashTag) Se llama #performstem. ¿Podíamos hacerlo más difícil? ¡Probablemente no! Perform de actuar, en inglés, y de que es el nombre del proyecto que nos trae hoy aquí. STEM, de Science, Technology, Engeeneering and Mathematics, joer tengo un inglés que ni Pablo Iglesias…

Así que durante el espectáculo, si tenéis preguntas, dudas o comentarios elogiosos, nos los mandáis a ese hashtag.

Pero oye, no aprovechéis esto de tener los teléfonos encendidos para jugar al candy crash, que nos conocemos, eh? Como mucho, a la salida, podéis ayudar a los científicos mediante apps. En serio, cualquiera de vosotros podría. Por muy mutantes que seáis. Gracias a los proyectos de ciencia ciudadana. ¿No os suena? Yo os lo cuento.

El primero es el Malaria Spot. Ya sabéis, la Malaria, esa enfermedad que es muy maaaala. Podéis ayudar a diagnosticar a la gente que está enferma de malaria para que les den el tratamiento adecuado y salvar vidas JUAGANDO EN EL MÓVIL. Con esta app que se ve en la pantalla Malaria Spot, ayudas a los científicos a diagnosticas a la gente y así les pueden dar el tratamiento más adecuado y salvarles la vida. Podéis convertiros en científicos desde ya, porque hay decenas de proyectos de ciencia ciudadana con los que podéis colaborar.

EW5: Students are shown the concept of citizen science using as an example mobile APP (Malaria Spot). Visual support is used, showing in the projection the image of the APP with its name (Malaria Spot) and putting as title of the slide "Citizen

Science".

Pero el que sí sabe de móviles es nuestro siguiente científico. Él viene de Castellón y es biotecnólogo, pero nos va a hablar de la transmisión de datos mediante dispositivos móviles. Un fuertísimo aplauso para Alberto Vivó.

5- ALBERTO DATOS

EW1: We create a monologue that talks about science and Mobile phones.

Soy biotecnólogo porque estudié biotecnología. Esa carrera es la número 1. Pero lo que de verdad es número 1 es la tecnología, sin el bio. Porque hasta una rata tiene un smartphone. Y ahora tienen cobertura 4G.

Tenemos aparatos muy potentes. Eso tiene ventajas. Pero también trae problemas como este:

- Se me han acabado los megas!

Cuando se te acaban los megas estás acabado, no te puedes comunicar con nadie. Es una mala noticia, que solo te puede dar una persona mala, como Ylenia:

- Se te acabaron los megas!

- ¡Ylenia! Por qué? Si yo solo he compartido noticias en pdf como las de revistas como Science, Nature y Muy Interesante.

- Y qué me dices de los vídeos porno?

- Oh. No fui yo. Fue mi hermana...

No! Fuiste tú, asúmelo. Cuando enviamos este tipo de archivos, estamos enviando un torrente de datos, en forma de ondas electromagnéticas, a la antena móvil más cercana. Estos datos codifican la información de la misma forma que ocurre en un ordenador: con el código binario.

Lo más fácil es enviar/codificar números porque se les hace corresponder a la intensidad de la onda, por ejemplo. Un 9 podría ser una intensidad máxima, y 1 a mínima, en medio podríamos tener el 2, el 3… etc. De modo que si recibes

intensidades 3, mínima, 3 y otra vez mínima, estás enviando el mensaje 3-1-3-1, que claramente no sirve para una mierda, a no ser que sea el código para entrar en el edificio de tu novia, sola en casa, si no responde al teléfono (o una broma mejor, pero aquí cabe una; igual el pin del móvil de tu novia? O la contraseña Facebook). Pero claro, si le asignamos la A al 1, la B al 2, C al 3… y así con todo el alfabeto… ese mensaje se convierte en … C-A-C-A, que tampoco sirve para mucho, aún. Porque de esta forma se podrían construir mensajes más completos. Claro pero para un ordenador o un móvil, o el sistema de recepción de señales, trabajar con 27 niveles de señal (el abecedario) es ineficiente. Para los sistemas electrónicos lo más fácil y eficiente es trabajar con dos niveles, apagado/encendido, pasa corriente/no pasa corriente, recibo señal/no recibo señal. Es el código binario.

Bloque 5: Como funciona el código binario

Entonces la unidad de información es un 0 o un 1, es un bit. Guay! Asigno la A al 0 y la B al 1… Muy útil para comunicarte con un mono o un concursante de gran hermano ABBAABBAABAB, pero para poco más… Pero claro, ¡podemos agrupar bits! Así dos 00 podrían ser una A, 01 una B, 10 una C y 11 una D. ¡Con dos bits ya podemos decir CACA! Y esto es un no parar, si juntamos 3 bits podemos llegar hasta la H, y con 4 bits a la P, casi lo tenemos, con 5 bits ya tenemos el abecedario, completo, con 6 bits incluso podemos mandar minúsculas y mayúsculas, con 7 bits asteriscos, símbolos de dólar e incluso almohadillas para los hashtags, con 8 hasta puedes meter caritas sonrientes, monos tapándose la boca y hasta la flamenca del whatsapp.

Bloque 6: ¿y un mega?

De modo que un Byte puede codificar un carácter, como una letra o un símbolo, eso está recogido en el código ASCII (la equivalencia entre símbolo y byte). Así 0110 0101 es una A (mirar porque no me lo sé de memoria) un byte. Y 1010 0111… (poner todo el código) es un “ola k ase” y ocupa 9 bytes. Guay! ¿Y si escribo el Quijote? Pues muchos bytes. Para hacerlo más fácil lo agrupamos en unidades que llamamos Bytes, KiloBytes, MegaBytes, GigaBytes, TeraBytes, PetaBytes, SuputamadreBytes… al igual que las unidades de masa se agrupan en gramos, kilogramos, toneladas; o las de potencias en

Watios, KiloWatios, MegaWatios, GigaWatios… Entonces un Mega es… X bytes.

Bloque 7: Más sobre los megas

¿Entonces si un “ola k ase” ocupa 9 bytes y tengo contratada una tarifa de 1 GigaByte al mes puedo enviar XXX “ola k ase” al mes? No, puedes enviar incluso más, porque la información viaja comprimida. De hecho mandar 3 millones de “ola k ase” podrías hacerlo de una forma inteligente con solo Y bytes y es lo que hacen programas como Zip, WinRar o parecidos (esto podría ser otro vídeo, como comprimir información). Entonces si mandar frases ocupa tan poco, ¿quién me esta chupando los megas? (con tono pijo, incluso imitando una pija, ropa incluso?, quedaría gracioso).

Bloque 8: la culpa es de los gatitos

Pues el resto de cosas que haces con el móvil, desde los gatitos, las partidas de Clash of Clans, hasta bajarte esa aplicación para hacer playback, el politono de Abraham Mateo o hacer Snapchats con fotos en el baño. Porque la información que contiene cada una de esas cosas es muchísimo mayor.

Bloque 9: imágenes

Y es que la información que puede haber en una foto es muy grande. Las fotos están hechas de píxeles, es la unidad mínima de información en una foto. Si te acercas muuuucho, muuuucho, muuuuuuuucho a una fotografía en los carteles de la calle, en la pantalla del portátil o del televisor, aparte de quedarte bizco durante 5 segundos, verás que la imagen no es continua, sino que está formada por puntitos muy pequeños de colores que al alejarte el ojo integra y hace parecer una imagen continua. Cada uno de esos puntos es un píxel y se puede codificar igual que las palabras. Claro, con un bit solo podríamos tener dos colores 0 – negro, 1 – blanco, puedes pintar una cebra; con dos 4 colores, con 3 ya podríamos tener los colores del arcoíris y todos los que un hombre puede distinguir; con 5 y 6 ya podemos pintar a Bob Esponja y con 24 bits, que es lo que se usa habitualmente, nos permite el verde turquesa, el verde aceituna, el verde esmeralda, el verde pistacho, el verde repollo/coliflor y todos esos colores que se encuentran en Zara: (el negro es el 000000 y el blanco el FFFFFF, esto es notación hexadecimal, otro vídeo, pero vamos, sustituye cada F por 1111 y lo tienes). Así cada

píxel, cada puntito mínimo en una foto, necesita de 3 bytes para poder mostrar un color. Obviamente cuantos más píxeles tenga la foto, más puntitos, más calidad tendrá (mayor resolución). Una pantalla de portátil tiene X píxeles, por lo que esa imagen ocuparía Y bytes. Claro, sin comprimir. El formato .jpg es un poderoso compresor de imágenes que reduce la redundancia que existe en casi todas las fotos

Imaginaos un video del youtube, 25 fotogramas, o imágenes por segundo, sonido incluido, las partidas del Clash of Clance…

Todo esto ocupa un montón, así que si nos quedamos sin megas antes de llegar a final de mes, no ha sido magia. Es que igual nos hemos pasado enviando vídeos donde sale gente como vino al mundo. Y, ¿qué le vamos a hacer? Podemos conectarnos a una wi-fi. Pero eso es de loosers. Podemos hacer cosas más auténticas, más peregrinas como jugar a la pelota, leer un libro, no sé, cosas donde Ylenia no nos pueda molestar. Así que:

TIKI-TIKI pa ti.

6- ALBERTO PRESENTADOR

Bien chicos, como os ha dicho Helena, podéis mandarnos preguntas, dudas lo que queráis. Pero no solo ahora, nuestro Hashtag está habilitado 24 horas. Si acaba el espectáculo, os vais a casa y observáis un fenómeno científico al que no le encontráis explicación… no se… como por ejemplo: sacas la leche súper caliente del microondas y al echarle el cola-cao empieza a hervir, o que tipo de polímero es capaz de permitir al tupé de Justin Viver violar todas las leyes de la gravedad. Cualquier duda, cualquier pregunta, ahora o mañana o cuando sea… nos lo enviáis a ese hashtag #BigVan.

GR: It promotes dialogue with students through social networks beyond the duration of the show. It highlights a fact of everyday life that has a scientific explanation, and students are encouraged to ask through the hashtag.

Porque la ciencia al servicio de las nuevas tecnologías nos permite crear una sociedad de la comunicación totalmente conectada. Con las redes sociales nos podemos enterar

de la última diarrea de Brad Pit. Pero la ciencia y las nuevas tecnologías sirven para mucho más. Hacen de nuestra sociedad un lugar más inclusivo, todo el mundo cabe, todo el mundo puede llegar a tener voz… ahora llegamos a donde antes era imposible. Por ejemplo, conocéis Molina de Aragón, provincia de Guadalajara? Pues claro que no, porque es un pueblo de mierda, donde nuca pasa nada. Pero ahora hasta tiene Facebook.

EW1 & EW4: We highlight that the development of Social Networks is a STEM job. We relate it with a European Societal Challenge: "generation of inclusive societies" using a joke with Facebook and isolated locations in Spain.

Nosotros, BigVan, Van con V, de Furgoneta, utilizamos YouTube para llevar la ciencia a todas partes. ¿Qué cómo? Pues con Eduardo Saenz de Cabezón y su canal de YouTube "Derivando" ¿Todavía no lo conocéis? Pues os lo presento, Edu era un friki, un empollón, uno de esos que son como el elemento neutro, no le miraban ni los tíos ni las tías… para él mejor, más tiempo pa empollar y jugar al MineCraft, que es lo que mola. Y ahora es un YouTuber brutal, y sus vídeos llegan a todas partes del mundo, a España, a América Latina, a Molina de Aragón a todas partes.

Os dejo uno de sus vídeos, la teoría del cuadrado cubo. Un aplauso, aunque sea en pantalla, para Edu Saenz de Cabezón.

7- VIDEO EDU: Mujeres Matemáticas.

EW6. Gender. To show actual/important women scientists as role models. Women in maths!

To give special attention to girls in maths and engineering.

We use a video where the role of important women in mathematics during the history of humanity is highlighted.

8- TEATRO A TRES

ORIOL.- Muchas gracias por los aplausos. La verdad es que uno se siente muy reconfortado. En mi laboratorio, aunque me salgan bien los experimentos, nadie me aplaude, porque las bacterias no aplauden, no tienen brazos para aplaudir, ni orejas para escuchar… solo con decir que para reproducirse ni si quiera follan, que se dividen…

HELENA.- Pero tus compañeros de trabajo eran bacterias?

ORIOL.- Bueno, no todos. Había levaduras, ranas, ratones, otros estudiantes de doctorado de química

ALBERTO.- ¿Doctorado de química? ¿Y la gente no te ralla la cabeza con eso de que podrías sintetizar drogas?

ORIOL.- -*cara de estupefaciente*- Sí tío, son unos cansinos, y mira que hacer un doctorado en Química no es sintetizar meta-anfetaminas, esto no es Breaking Bad.

HELENA.- Qué manía de machacar a los científicos con cosas de estas. Nosotras no vamos por ahí diciendo: -oye, ¿en qué trabajas? –Soy panadero. –Pues podrías hacer una barra de pan con forma de polla. No hacemos eso.

ORIOL.- A ver a ver, es cierto que con una carrera científica, tecnológica o de mates puedes pillar un mogollón de curros, trabajar en cosas inimaginables,

HELENA.- Yo en tercero de la ESO siempre quise ser piloto aviones,y diseñarlos y construirlos

ORIOL.- Ahí hay física, mates e ingeniería a tope

HELENA.- Ya en 4º de la eso me molaba más desarrollar videojuegos

ORIOL.- ahí sin matemáticas, cálculo o programación no pasas del Tetris

HELENA.- En bachillerato me incliné por el deporte porque me encanta jugar al fútbol

ORIOL.- Biología, química, nutrición, hasta matemáticas para calcular estadísticas de juego…

HELENA.- Y al final me hice Ingeniera Genética. Estudiando biología, química y física a tope...

ORIOL.- en las excavaciones arqueológicas, en las encuestas electorales, en el zoo, la ciencia está en todas partes, en muchísimos trabajos. Y uno de ellos, el que yo escogí:

ser INVESTIGADOR. Para ser investigador debes hacer un doctorado, donde aprendes a resolver los problemas y enigmas que plantea tu investigación utilizando el método científico.

EW1. To highlight that some well-considered jobs are actually STEM-Jobs. To highlight that Science and STEM-Jobs are everywhere (including private companies). **EW6:** To highlight that STEM-Jobs are not gendered showing that girls are actually working as Engineers, computer scientists. We use the personal example of the woman who is performing.

ALBERTO.- ¿Lo qué?

ORIOL.- Ya sabes, el método científico: observación, hipótesis, experimentación y conclusiones.

ALBERTO.- ¿Lo qué?

ORIOL: Vamos con un ejemplo. Se observa algún fenómeno del que no tenemos una explicación clara

HELENA.- (paso adelante) Alberto se da cuenta de que tiene pocos seguidores en Instagram

ALBERTO.- ¿Eingh?

ORIOL.- hipótesis, planteamos una posible explicación para ese fenómeno

HELENA.- Es muy posible que Alberto no esté subiendo suficientes fotos como para ganar seguidores

ALBERTO.- Aahhaaahah

ORIOL.- Experimentación, diseñamos y hacemos una serie de experimentos para validar o refutar nuestra hipótesis

HELENA.- Alberto intenta hacerse un buen selfie y lo sube a Instagram (aparece un selfie de Alberto en pantalla, selfie del sapo toro)

ORIOL.- y conclusiones. Interpretamos los resultados obtenidos para saber si nuestra hipótesis era correcta, o no

HELENA.- Alberto ha perdido un montón de seguidores.

ALBERTO.- Ha dejado de seguirme hasta mi madre

HELENA.- Conclusión, no solo hay que subir selfies a instagram, también hay que subir selfies con un poquito de calidad.

ORIOL.- Y a esto me dedico yo, no a hacerme selfies, sino a seguir un método científico. Soy investigador el BIO-NMR:LAB de la Universidad de Barcelona, donde intento entender cómo las bacterias se organizan dentro de nuestro cuerpo para causar enfermedades. Así contribuyo al crecimiento de la sociedad. Y soy partícipe de los avances médicos, tecnológicos y sociales.

HELENA.- Y creo que eso es mejor que querer ser tronista.

ALBERTO.- Lo bueno de incorporar el método científico, es que luego puedes usarlo para todo. Te conviertes en el Fran de la jungla del mercado laboral.

ORIOL.- La verdad es que no hay mucho paro entre los científicos.

HELENA.- No hay nada. Menos del 5% de la gente que acaba un doctorado está en paro.

ALBERTO.- Fijaos en mí, yo mismo me he hecho empresario con mis amigos de Big Van *(mira al lugar 'del gramático)* sí, con V de furgoneta, y estamos haciendo lo que nos gusta de verdad... .- Juntar ciencia y artes.

H: Ciencia y teatro

O: Ciencia y literatura

A: Ciencia y video

H: Ciencia y radio

O: Ciencia y Youtube

EW1: Stem Jobs. To highlight that some well-considered jobs are actually STEM-Jobs by showing personal examples of the performers.

ALBERTO.- Se pueden hacer un montón de cosas cuando estudias ciencia. Investigar, divulgar la ciencia, trabajar en una empresa, enseñar, montar tu propia empresa…

EW1: Stem Jobs. To highlight that Science and STEM-Jobs are everywhere (including private companies) by listing some examples.

ORIOL: Yo he investigado la comunicación, pero a niveles súper primitivos…

HELENA: ¿En serio?

ORIOL: Síiiii

ALBERTO: Pues cuéntaselo a esta gente, que con nosotros ya te has comunicado mucho…

- *Helena y Alberto salen de la sala –*

9- ORIOL FUEGO

Estaba yo el otro día pensando, los científicos somos mucho de pensar, nos pagan para eso, best job ever, así que me llevé el trabajo a casa. Estaba en el sofá, teniendo una reflexión científico-filosófica profunda, viendo mujeres y hombres y viceversa y pensé… el ser humano es extraordinario, ¿verdad? ¿Cuál será el mayor invento que ha hecho la humanidad? De seguida me vinieron a la cabeza grandes inventos, agarras un caramelo, le pones un palo y tienes un chupachups o agarras un móvil le pones un palo y tienes un "selfie" o…

1- ¡La batamanta! ¿Tienes frio, he, perra? ¡Pués abra cadabra tápate guarra!

Son cosas que nos han cambiado la vida, nos la han hecho más sencilla, más dulce, más aterciopelada… Y entonces, la presentadora del programa, que creo que se llama viceversa, dijo algo y pensé en la evolución… o la des-evolución, y me dije: ¡No! ¿Cuál es el mayor, pero el primer gran descubrimiento, el que nos separa de los animales y nos convierte en personas? Ahí lo tuve claro: EL FUEGO

De acuerdo, atemperad vuestro entusiasmo. Entiendo que el fuego a día de hoy os pueda parecer banal y mundano porque lo tenemos totalmente controlado: en una

cerilla, en el fogón de casa, yo a las cinco de la madrugada en una discoteca… pssssst

Pero imaginaos el primer homínido en utilizar el fuego. El monillo flipando en full HD, pensando… ¿esto que hé lo que hé? ¿Ezto ze come? ¿Sabéis quien fue el primer homínido en empezar a utilizar el fuego puntualmente? No, no se trata de una pregunta retórica, es de las de contestar.

Es el *Homo habilis*, que pobló el África subsahariana hace 1.800.000 años, os lo podéis imaginar, así de alto *–indicar aprox 1,3m-* con el cuerpo cubierto de pelo, los brazos largos, el mentón grande *–ir representando todas estas características-* y de golpe llega una tormenta y cae un rayo, sobre un árbol, y enciende un fuego, ya es casualidad, y el *Homo habilis* aprende que el fuego calienta, que puede coger un palo de madera, encenderlo, y clavárselo en la cara a otros monos, si es muy puteón, o irse a las afueras, quemar un bosque, construir unos chalets, nace el primer especulador de la historia…

Peeeero, estos alegres "monillos" no fueron lo suficientemente "habilidosos" como para transmitir el conocimiento de utilizar un fuego de unos individuos a otros. Claro, estos antiguos humanos lo único que podían decirse entre ellos era algo así como "UHU HUHU HU" *–hacer movimientos de mono o orangután mientras se grita-*. Si habéis visto un meeting de Donald Trump, sabréis a lo que me refiero.

Pero lo bueno que tienen las leyes de la naturaleza, es que aunque no creas, te afectan igual. Y un millón de años de evolución después, aparece en la Tierra, el "*homo erectus*", unos homínidos que destacaron por su potentísimo aparato… fónico, ya eran capaces de utilizar un lenguaje articulado. Si un *Homo erectus* aprendía a encender un fuego, pues yo que sé, utilizando un Samsung Galaxy 7, por ejemplo, podía enseñar a sus hijos, a sus compañeros, cómo hacerlo.

Este gran avance en la comunicación y la cooperación entre homínidos nos permitió evolucionar como especie. El control del fuego nos ayudó, entre otras muchas cosas, a iluminar cuevas, en las que nos pudimos meter a vivir, espantar a bestias salvajes, permitiéndonos proteger mejor a la tribu, y lo que, ahora sí, considero el mayor

descubrimiento de la humanidad: Inventamos… LA BARBACOA

Gracias al fuego empezamos a cocinar los alimentos, lo que los volvió mucho más blandos, haciendo que nuestro mentón se redujera. Pero además se amplió altamente la gama de alimentos que podíamos comer, y también su cantidad. El aumento en el aporte de energía a nuestros cuerpos permitió, entre otras, que nuestro cerebro creciera y se ampliara cada vez más. Esto se nota más en unos individuos que en otros… la evolución puede ser muy cruel. Pobre Paquirrín.

El problema está en que decir que la cooperación y la comunicación entre individuos influyen en el proceso evolutivo iba en contra del conocimiento establecido. Lo que se sabía hasta el momento, lo que estaba bien demostrado por las tesis Darwinistas, es que era la especie más fuerte, la más egoísta, la que mejor se adapte a los cambios la que sobreviva y por lo tanto la que evolucione...

¿Cómo superar un dogma científico? ¿Cómo romper con un conocimiento preestablecido? ¿Con un martillo? ¡No! Con experimentos que demuestren las nuevas ideas, y yo me he traído conmigo un experimento, en real time, para demostraros que comunicación y cooperación son esenciales en el proceso evolutivo.

Pero no puedo hacerlo solo. Para ello necesito 2 voluntarios. A ver, ¿quién se atreve?

[El juego con los voluntarios]

GR: Make the PERSEIA interactive taking two volunteers from the public to try to light fire using a bow, a rope and a wood stick.

Bueno, no os preocupéis, que no lo consigue nadie. ¿Sabéis por qué? Porque falta un elemento absolutamente esencial: la comunicación.

¿Sabéis quien fue el primer científico que consiguió demostrar científicamente que la cooperación entre individuos influye en el proceso evolutivo de toda la especie? Una

mujer claro que sí. Ella fue Lynn Margulis *(decir Margulis haciendo un movimiento de cuerpo así raro, de escalofrio, pero de escalofrio bueno, de gustirrinin)*.

Aunque ella trabajó con bacterias, las teorías de Margulis *(movimiento)* fueron tan importantes, que pueden aplicarse a todas las especies que pueblan el planeta. Margulis *(movimiento)* cambió el funcionamiento y la manera de entender el mundo.

Y esto es algo que me molesta bastante, porque hay un montón de grandes descubrimientos hechos por mujeres y luego no se les dá la importancia que merecen. Por ejemplo, Hedy Lamarr… conocéis a Hedy Lamarr? No, no habéis oído hablar de Hedy Lamarr? Pero si es "La Marr" de famosa. Pues gracias a ella hoy en día tenemos… ¡el wiffi! ¿Qué haríamos sin wiffi, hablar? Gracias Hedy, has sido la-marr de útil para la humanidad.

EW6. Gender. To show actual/important women scientists as role models. In order to facilitate that students remember the name of the Scientists, make a joke using the name.

Pero Margulis o Lamarr fueron mujeres valientes, no les importaba meterse a trabajar en laboratorios donde solo había hombres, no les importaba que las señalaras con el dedo y las llamasen machirulos, por estar haciendo un "trabajo de hombres". Ellas estaban seguras de sí mismas, tenían confianza en ellas mismas, y eso les permitió convertirse en auténticos iconos de la ciencia.

Así que ya sabéis, dejémonos de tanto competir, de tanto dejar de lado a los que son distintos a nosotros, porque cooperar, también es salir adelante.

Muchas gracias.

10- TURNO DE PREGUNTAS

1. Rescatar la encuesta de twitter sobre los genes. Asociar las normas éticas a que hay investigaciones sobre conocimiento básico y sobre medio ambiente.

GR: Use of social networks. To allow students to make questions or to give their opinion after the PERSEIA.

SMS PERSEIA Script

In this case, SMS developed a specific busk for each one of the guidelines. In this sense, SMS PERSEIA script is showed following this division.

Stem Market busk

Anybody ever fancied a career in medicine? Anybody ever fancied being an engineer? Well I am very lucky to know some people who combine both of these things in order to save peoples' lives!

So there you were a few years ago climbing on climbing frames, swinging on swings, and you know how it goes, no matter how careful we are someone some time is going to fall off! Imagine my hand is me as I fall from the top of a climbing frame to the floor, and when I hit the ground (busker slaps one hand loudly onto another), there is an impact! I might stick out my hands to break my fall, but this only protects me by maybe breaking my arms ☹. So the problem is how to control my impact with the ground? And I need 2 volunteers to help me out.

Busker and volunteers throw tennis balls and then water balloons between each other noting how we spread impacts over time and distance.

Now my good pal Nikki from Cardiff University tries to work out how to save our arms and legs (and lives!) by pulling people up to the ceiling on a rope, dropping them and seeing what happens when they hit the floor! And I need 2 volunteers to help me do just that? Thank you so much for volunteering, but really our insurance would never

let us drop anyone from such a height, but amazingly I have 2 volunteers here who have both signed a piece of paper saying its fine to drop them! They are called Eggwood and Eggweena

Busker hands the eggs to the volunteers and gets them first to drop the eggs onto a super soft floor (bubble wrap) and then on to a hard floor.

Nikki and her medical engineering pals use their science and maths skills to create super soft floors in play grounds to prevent what just happened to Eggwood and Eggweana happening to us! Science and engineering are everywhere, playgrounds are full of them!

And no matter how many times things don't quiet work out (a lot!) Nikki and her pals keep on dropping things, keep on gathering evidence and thinking. Persistence is important as a scientist!

You might become a medical engineer like Nikki and use your science and maths skills to save peoples' lives!

Never mind saving one life, the engineers and scientists who work for organisations who look after our countries cyber security like GCHQ use their programming skills to keep our democracy safe, science and engineering can be as important as that!

Stereotypes busk

Busker comes into the room, wearing a football shirt underneath a tabard, underneath a lab coat and goggles holding a boss stand and clamp.

Hi all my name is David and you have to try and guess my profession!

Nice one, you got it right I am a scientist, but does that mean science is all I do? (busker plays table tennis, and dances with the teacher present) I have likes and

dislikes outside of what I do just like anybody else! Some scientists do see a lab coat as some sort of uniform, but that's not to say they think this wholly defines them!

And anyway I am not really a scientist, who am I?
Busker rips off lab coat to reveal hairdressers costume, holding scissors and a comb.
Yes that right I am a hairdresser and I need some one to come and cut my hair (busker pulls on a wig, and hands the scissors to the volunteer). You know in hair dressing a knowledge of geometry and angles is absolutely essential, they are really important in the measurements needed to make a good hair cut!

(Busker gets volunteer to hold hair at various angles and asks the rest of the audience if these are correct, then get the volunteer to cut some hair)

Not only does a hairdresser need to know their angles, but also as a small business person they probably spend as much time using one of these (busker holds up a calculator) as they do using scissors and combs. Without a knowledge of maths to control say your stock levels, you would soon go out of business!

(Busker now strips off to a football shirt and holds a football)
Ok if I am not really a hairdresser what's my profession? WRONG I am a physicist! Or at least any control I have over this football is down to physics
(busker launches spinning discs at the audience, then uses spinning polystyrene cups to illustrate the importance of spin in making a football do what you want it to do)
That incredible free kick that swerves like a missile into the top corner of the goal is down to spin, which is down to physics! Science is everywhere touching all our lives!

(Busker drops something on the floor)
Who thought a lot about that? Yes Mr Newton. But this science stereotyping can get really interesting at times, because if he was not famous for his work on physics and

mathematics' he would still be world famous in the world of religious scholarship! When I first joined our company, I worked with 7 female scientists who all believed in god ☺

Ethics busk

(Just after the busking warm up, the busker complains, that they would love to get to know everyone in the room personally, but there is just not time for this, so the best we can do is to shake the hands of 3 pupils in the audience and then get them to shake everybody else's hands! Prior to pupils entering the room, the busker has covered their hands in fine silver glitter)

(At the very end of the busking set)
Hands up if you have some glitter on you? Wow nearly everybody in the room! What if instead of glitter that had been a really infectious disease, we might have all got really ill! Some diseases can spread that fast!
So if I said that some scientists were trying really hard to help deadly disease's spread even faster (in a laboratory!) would you agree with that? NO, why not? (busker gathers opinions).
Well said people! But ethically we have to ask why the scientists are doing this research ????? And for the most part it's so we can better understand how these diseases spread so fast so that we can become better at stopping them.

Scientists are very carefully regulated in their work, no way would they get funding if there was anything suspect about their research into such deadly diseases.

But that's not to say that scientists don't go in for some pretty blue sky thinking at times, they do and its one of the most amazing things about research and for that matter being human, we need to know more because we need to know more!

EU Societal Challenges busk

When we ran the focus groups, one of the things you told us was that you really wanted science to help people and the environment. Well let me introduce you to a guy who really agrees with you on that score, let me introduce to you Pete the scariest rabbit in the world!

(Busker, uses a volunteer to run the incredible expanding rabbit illusion demonstration)

So what happened to Pete? Yes he got bigger! And I want to introduce to you another kind of peat, made of dead and decaying plant matter that has built up over 100,00's of years in wet and low oxygen environments, which is really important in safe guarding our environment.
This type of peat also gets bigger when you add water, and to help us think about this we are going to play a game of scientific observation

(busker plays the 3 cups game with the audience. Water being poured into one cup, then the cups are moved around with the audience being instructed to follow the water. Eventually the water is poured in to a cup containing sodium polyacrylate, this cup is then poured over the teachers head!)

But you see I used some science to fool you, your teacher is still dry because I used a substance that I placed in the cup called sodium polyacrylate to… ???? yes absorb the water. And that is what peat is so very good at doing in our environment, and I need another volunteer to help me look at this!

(busker gets volunteer to push the plunger down on a large bore syringe containing some peat blocks and above the blocks some dirty water, audience notes how slowly the water drips out of the syringe as it is filtered by the peat.)

And that is what peat does for our environment and has done so for millions of years. It helps to slow the path of water through our environment so living organisms can take full advantage of the water.
(Busker and volunteer now repeat the syringe demo, but with a syringe filled only with clean water. As the volunteer pushes down on the plunger, the busker so angles the syringe so that it sprays the water over the audience.)

See what happens when we don't have peat to slow our water down! It shoots into our drains and rivers so fast that we get lots more… ??? yes flooding! And as we dig up peat to burn in generating electricity and also cover more and more land with tarmac and paving stones, this is only going to make things worse! In some countries the flooding can get so bad that the top soil of the land gets washed away, so its really hard to grow any plants and crops for anything to eat!

We have to look after peat and similar environments so they can look after us! Any you know who gathers the evidence for this, to go to governments and help them put policies in place to help the environment, mostly its scientists, fighting to save our planet.

We work with an organisation called bioversity that works with scientists around the world to promote and use to its fullest sustainable potential the incredible biological diversity of planet earth. Scientists improving people's lives and safeguarding our planet.

Gender Bias busk

Hands up if you think girls are better than boys?
Hands up if you think boys are better than girls?

Science and engineering is for everyone
Science and engineering is for every gender.

(Busker asks for 4 volunteers 2 boys and 2 girls roughly equal in size. Busker engages them with a centre of mass game, where from a fixed kneeling position on the floor and with their hands behind their backs. The volunteers have to attempt to touch their noses on the floor and come back to an upright kneeling position without using their hands. Done as a competition between boys and girls, girls usually win.)

So girls won there (busker explains why with reference to centre of mass science). But in most of the focus groups I was involved in it was amazing to here you all pretty much agree that there was an equality between the sexes, one that was not perfect, and that we all need to work hard to make stronger and fairer, but non the less an equality. Lets celebrate this equality with some mathematics!

(busker runs the 4 chair Wallis grid self supporting structure demo with the 4 volunteers)

In Science Made Simple we were looking for a structural engineer to help us write a show about the science of bridge building (and super heroes!) And we found one in the shape of Kelly Croke, who had just finished working on a beautiful bridge in Cardiff.
Kelly does not wear a boiler suit
Kelly is not covered in oil and grease
Kelly uses her maths and science skills to solve bridge building problems. Kelly is an engineer!
Kelly gets paid very well for what she does, and drives to work in a rather nice BMW ☺

Dialogue Science and Society busk

HI there people, I have some science related factoids, I want you to all to know. But

the information can only be passed on one way, yes it's the strictest whispering game you will ever play!

(Audience split up into 3 groups of 10, with each group being given a message to pass along only in 1 direction)

Hard to do is it not?! For the effective transfer of understanding we need a dialogue, both a giving and a receiving of information.

(busker and a volunteer, stretch and then move the coils of a slinky between them as a physical example of the transfer and synthesis of information)

And this is as true in science as anywhere else! As a science communicator my job, my working life revolves around promoting such a dialogue. Science really needs you to be part of that dialogue as well. Really right now!
Eg British Trust for Ornithology and its garden bird watch / UK ladybird survey/ Track a tree survey

And if you want to have a talk to a scientist, have a chat with your science teachers about this. They will mostly come from a science background and are your one stop shop for accurate scientific info and opinion!

Busking introduction (warm up)

After a brief introduction to the project.

Tell me about some technology?

You know we live in an incredible technological age! I used to work in a museum in

Manchester with one of the very first proper computers from the 1940/50's in it, its nickname is baby, but it is a very big baby as you would hardly be able to fit it into this classroom!

But now such is the increased power of technology that your average smart phone carries more computing power than was available in the whole of the vehicle that first landed human beings on the moon!

Who likes Harry Potter? Why do you like Harry Potter?

Harry and his pals use magic for good, maybe I could teach you something, not good magic, but cool science, something real and interesting

(busker runs mobile phone inside a balloon demo using science and then instructs audience how to do this (audience uses fake mobile phones!))

In many ways my job as a science communicator is to use demonstrations like that to highlight the science in peoples lives and invest it with a little bit of wonder and make it sticky ☺

Conclusion

Pupils asked what they thought of the session?

Selfie stick image taken of whole audience with props

Pupils asked to respond to the selfie image on social media

TRACES PERSEIA Script

In this case, as in TBVT script, comments show the additions or modifications made by TRACES after doing the EW.

All the performance is built on irony and plays with stereotypes, as well as about youngsters, scientists, etc

Performer 1, the young teenager, is a girl. And she is the one who wants to become a pilot, an architect or a business woman. Moreover, the 2 scientists in the PERSEIA are a woman and a man, and there are no really differences between them, as scientists

We invite the students to switch on their phones and use social media

Debate at the end of the PERSEIA

We invite someone from the audience, to come on stage and to be volunteer for an experiment about the effect of low batteries on their phones

1er tableau

« Poussin », a teenage girl, and her father. When he enters the room, he protects himself with an ombrella. Poussin is quite agressive, a bit like a wild beast.

Entrée de Poussin, regard de défi avec le public.
Le père toque à la porte.

Lui
Hou hou !
C'est papa !

Elle
Non.

Lui
Tu es là ?

Elle
Non.

Lui
Je t'entends !

Elle
Non.

Lui
Papa va rentrer.

Elle
Non !

Lui
Attention. Tu es sage.
T'as passé une bonne journée ? Non ! Non non non ! Attention !
(aparté) Ce qu'il faut d'abord, c'est établir le contact.
Elle lui lance le coussin
Non ! Non ! A 'tention !
(Ouvre son parapluie pour la chasser.)
ALORS !
Assieds toi, papa va te… Ah ah ah ! Assieds-toi, papa va te… Voilà. Assieds-toi.
HA HA HA ! Assis ! ALOOORS !!
(il récupère le coussin)

Non c'est papas qui te donne. Dou-ce-ment.
(aparté) Oui, on acquiert un certain… Toujours être sur ses…
Tu bouges pas. Regarde. (il lui tend le coussin, elle essaie de le prendre). C'est papa !
Voilà. C'est bien ! C'est bien ! Qu'est-ce qu'on dit à papa ? Qu'est-ce qu'on dit à papa ?
Hein ?

Elle
Sors de ma chambre.

Lui
Oui… Non non… Avant, quand elle était petite, elle disait, vous savez quand on... Elle disait… Mais non, là, c'est…
Alors papa doit te parler. On doit remplir un papier pour ton orientation. « Formulez trois vœux pour votre avenir professionnel. »
Oui enfin quel métier tu veux faire. Trois !
Quel métier, plus tard ?

Elle
Prrt…

Lui
Que ?

Elle
Prrrt…

Lui
Ah ! Ah oui alors ça, vous entendez ? Quel métier tu veux faire plus tard, Poussin ?

Elle
Prrrt…

Lui
Quel métier ?

Prrrt…

Lui
Ah ! Si si si, ça a un sens !
Qu'est-ce que tu veux faire comme métier plus tard ?

Elle
Prrrt…

Lui
Vous entendez ?
Non, ça peut vouloir dire euh : Je sais pas ou alors je m'en fous. Ou parfois les deux.
ALORS !! Là ! Assis !
'tention, le moindre moment de… peut s'avérer…
Alors… Trois métiers.
Oh ! Qu'est-ce que c'est ça ? Qu'est-ce que c'est ça ? Tu le veux ?

Elle
Papa !

Lui
Qu'est-ce que c'est ça ? T'as vu ?

Elle
Donne-moi.

Lui
T'as vu ? C'était là, c'était dans ma poche !

Elle

C’est à moi.

Lui
Qu’est-ce que c’est ?

Elle
A moi !

Lui
C’est pour qui ?

Elle
C’est pour moi !

Lui
Ah bon, c’est pas pour papa ?

Elle
Pour Poussin !

Lui
C’est pour Poussin ? C’est pour Poussin ?

Elle
Poussin !

Lui
C’est pour Poussin ? Oui c’est pour Poussin ! Là, voilà.

Elle
Papa ?

Lui
Regarde, c’est pour Poussin. C’est pour Poussin ?

Elle
Papa ? Câlin ! Câlin, papa.

Lui
Ooh…

Elle
Câlin.

Lui
Ooh…

Elle
Câlin, câlin…

Lui
Tu le veux ?

Elle
Oui !

Lui
Non. Trois métiers.

Elle
Business woman.

Lui
Hein ?

In the next 3 pages, the comedians are using the 3 more positive STEM-jobs that students have selected (Business woman/man, pilot and architect) and are amplifying and caricaturing the main positive features of these jobs. And at the end of this dialogue, Raphaël (the father) explains to his daughter (but she doesn't really understand) that they will make mathematics and sciences together, if she wants to choose one of these 3 jobs. Futhermore, as Anissa, a girl, plays these different "jobs", it really shows that both men or women can make these jobs.

Elle
Businesswoman.
Businesswoman. Allo ? Non, tu ne vends pas à moins de 300 000 Ah non non. Ils veulent nous arnaquer. Hors de question. Tente 400 000 direct. Fais les bisquer. Appelle les allemands, voir, hein ? Attends je te reprends. Assistant ? Un café.

Lui
Hein ?

Elle
Un café.
Oui allo ? Taxi moto dans quinze minutes ? Bon, tu lui dis que je suis pas à son service,

non plus !

Lui
Elle a une imagination !

Elle
Faut que je négocie avec le Japon, là.
Oui allo, je dois partir à l'aéroport. Oui, je vais à Toronto pour la nouvelle succursale.

Lui
Donc je note…

Elle
Il arrive ce café ou quoi ?

Lui
Hein ?

Elle
Il arrive ce café ou quoi ?
Je t'avais demandé une prospection sur Tokyo, ça fait au moins dix minutes que j'attends les infos, tu te fiches de moi !

Lui
Donc je note ?

Elle (toujours dans son rôle de businesswoman agacée)
Oui ? Quoi ?

Lui
Je note business…

Elle
J'avais demandé un café !

Lui
Oui… Non…Euh… Donc c'est noté, businesswoman. Ensuite. Deuxième. (temps) Oh mais qu'est-ce qui m'arrive ! (son bras a des spasmes et il manque de lancer le téléphone)

Elle
Papa !

Lui
Ensuite. J'ai dit : ensuite ! (il fait mine de jeter le téléphone)
Elle
Papa ! Papa ! Non ! Arrête ! Papa…

Lui
Oui ?

Elle
Papa, je t'aime.

Lui
Hahahaaa.

Elle
Papa câlin

Lui
Ahhh poussin…

Elle
Papa, le plus fort, le plus fort des papas.
Le plus beau et le plus fort des papas.

Lui
Oh arrête… C'est vrai j'ai fait un petit peu de sport…

Elle
Papa je t'aime.

Lui
Oooh aaah… Oh, tiens…. Tu rigoles ou quoi !!

Elle
Architecte.

Lui
Architecte ?

Elle
Ouais ! Comme ça j'aurai de l'espace ! Je vais avoir un appart de folie… 800 mètres carrés, avec une immense baie vitrée avec vue sur le Mont Saint-Michel d'un côté et la Tour Eiffel de l'autre !

Lui
Ah oui !?

Elle
Ouais, spacieux, cathédrale, du volume, du volume du volume. De l'air, quoi. Euh stagiaire ? Un café s'il vous plait.

Lui
Oh non ! Pas encore !

Elle
Et puis j'aurais les hommes politiques au téléphone, ils me diront : comment vous le voyez, ce monument historique ? Ah moi, je verrais bien une érection végétale, minérale, un mélange de matière, je verrais bien tu vois le côté aquatique… Mon café là, oh ! Dis donc, vous l'avez commencé quand, votre stage ?

Lui
Mais enfin je suis pas… Je suis pas… Bon en troisième ?

Elle
En troisième…

Lui
ALORS !

Elle
Euh… Bip bip toup toup toup

Lui
Attends attends je sais ! Dactylo !

Elle
Clic clic clac. Stewart !

Lui
Oui ?

Elle
Ca fait trois fois que je demande un café.

Lui
Ah non, cette histoire de café… Je n'ai pas de café ! Je n'ai pas de café ! Non mais

vraiment !

Elle
Crew crew crew, position position ! Armez les toboggans.

Lui
Ah… toboggan… animatrice de centre de loisir !

Elle
Tour de contrôle, demande autorisation pour décollage.

Lui
Ah je sais ! Pilote, pilote ! Commandant de bord ! Je note.

Elle
Tour de contrôle ? Mesdames et messieurs, ici votre commandante de bord qui vous parle… Bienvenue à bord de notre boeing à destination de Hawai. La température extérieure est trop bien… Hep…

Lui
Me demande pas de café, parce que si j'… En tout cas, c'est bien, on va pouvoir faire des maths ensemble.

Elle
Hein ?

Lui
Oui, je t'aiderai pour tes maths…

Elle
J'ai pas dit math !! J'ai dit Pilote. J'ai pas dit math, j'ai dit architecte.

Lui
Oui, oui, justement…
Elle se renfrogne.
C'est bien poussin. Papa est content. Regarde !

Elle
Papa ! Papa ! Papa…
(Elle prend le téléphone)

Lui
Fais un bisou à papa.

Hein ? Ah non, là c'est terminé. Là on ne peut plus rien, là je n'ai… Non non non ! Ca ? (Désignant le parapluie) Ah ça j'ai plus besoin, oh la la, regardez, je le pose. Non non non, y en a pour des heures, là. Regardez, je m'approche… (petite danse devant elle). C'est sans… pensez donc ah non, y a plus de danger.

Elle
Papa ? (elle le photographie.)

Lui
Non faut pas s'inquiéter, c'est juste un reflexe, comme la grenouille avec l'électricité.

1er exposé

(They change costume, and you understand that in fact they are speakers giving a lecture).

Lui
Voilà.

Elle
Voilà.

Lui
Donc, le Jeune.

Elle
Le Jeune et son rapport au Vieux. Sujet d'étude s'il en faut.

Lui
S'il en est.
Nous avons souhaité étudier le Jeune européen…

Elle
Juvenis europaeus !

Lui
…le Jeune européen en milieu urbain.

Elle
En ville quoi. Après l'avoir observé dans son lieu d'habitation, nous l'avons étudié dans son lieu d'élevage quotidien où il se trouve de 8h à 17h environ.

Lui
Dans ce lieu d'élevage, il est divisé en sous groupe de 20 ou 30 éléments encadré par un ou plusieurs vieux.

Elle
Oui, le jeune est toujours encadré par des vieux. Pourquoi ? Qu'adviendrait-il si le jeune n'était pas encadré par des vieux ?

Lui
Et bien, il est comment dire, il devient, c'est assez difficile à expl, il est, ha, enfin il…

Elle
Il est chiant. Ultra chiant.

Lui
C'est prouvé !

Elle
Scientifiquement.

Lui
D'ailleurs le Jeune entretient avec la science un rapport ambivalent.

Elle
Ambigu

Lui
Ambivalent.

Elle
Chose étonnante, le Jeune veut faire des études de sciences, mais il ne le sait pas.

Lui
Et non. Le Jeune veut devenir Pilote. Mais alors quoi ? Pour être pilote, il faut étudier Ronsard ? La poésie ? (ils rient)

Elle
Le jeune veut devenir architecte.

Lui
Et alors ? Pour être architecte, il faut étudier le saut en longueur ? (ils rient)

Elle
Mais ne nous moquons pas.

Lui
Ce que le jeune attend de sa carrière future, c'est de voyager, de parler des langues étrangères…

Elle
Yeah ! You know, when you go to New York, you speak in English, you feel so cool, you feel like confident, you feel… everything is amazing, even in your body, you feel like chewing gum, when you're moving you know, you're just so cool ! (ad lib)
(arabia)
Elle s'assoit.
Y cuando tú hablas español, te sientes enseguida diferente, como caliente adentro. Es un idioma muy sensual, como un baile de flamenco, de tango, de salsa, de ritmo latino. Y también, en tu boca, el idioma español te hace viajar a una civilización de contacto fisico. A mí me gusta muchíssimo.

Lui
J'ignorais que vous aviez ces talents !
Nous en arrivons maintenant à la découverte majeure de notre étude.

Elle
Qui a fait l'objet d'une publication dans la revue Science.

Lui
Il est d'une importance primordiale pour le jeune de rester connecté.

Elle
C'est vital. La moindre panne de batterie peut virer au drame.

Lui
Nous avons été les témoins d'une scène d'une rare violence.

Elle
Un matin sous nos yeux, un jeune se plaignant d'une violente panne de batterie.

Lui
Nous n'avons pas tout de suite pris la mesure de l'incident.

Elle
En un instant, le jeune tombe, inconscient. Chblam, vlan, paf. Ventilation faible, pouls

filant.

Lui
Les pompiers sont arrivés, ils nous ont dit : vous auriez appelé cinq minutes plus tard, c'était terminé. Après ce phénomène, nous avons poussé nos recherches, et nous avons découvert qu'il y a trois situations d'urgence dans lesquelles le jeune voit son espérance de vie réduite à quelques minutes : 1

Elle
Abandonné en plein désert du Sahara, sans eau ni vivre.

Lui
Déshydratation, insolation. 2

Elle
Pris dans une avalanche en haute montagne, sans eau ni vivre.

Lui
Asphyxie, hypothermie. 3

Elle
Panne de batterie, sans chargeur, sans eau ni vivre.

Lui
Cause de la mort encore à déterminer.

Elle
Nous y travaillons.

Lui
Mais nous manquons de volontaires.
Il s'agit évidemment d'un phénomène récent, néanmoins extrêmement préoccupant ; observable probablement depuis quelques années tout au plus.

Elle
Ben oui, avant on avait pas de portable. 87% des collégiens ont un portable. Vous en avez, vous ? Montrez voir.

Lui
Oh celui-là, on peut retirer la coque ?

Elle (elle va chercher la table, la valise….)
Oui, il est bien celui-là. Bienvenue. Merci de vous porter volontaire. Merci de faire

partie de ces gens qui font avancer la science. Merci de donner de votre temps, de votre personne.

Pour des questions d'éthiques nous allons vous demander de bien vouloir signer un consentement à participer à notre étude. Lisez le bien, c'est important. Enfin non, ne lisez pas c'est trop long, je vous explique.

Formulaire de Consentement libre, éclairé et exprès

Expériences comportementales en psychologie cognitive

Vous pourrez prendre le temps de lire et comprendre ces informations et de réfléchir à votre participation.
But de l'étude :
Conséquences physiologiques de la panne de batterie chez le jeune.

Risque potentiel : (elle lit la longue liste…) bon euh nombreux, mais négligeables au regard du bénéfice attendu.
Bénéfice attendu : connaître davantage les causes exactes du décès, et concevoir des services de secours appropriés.

Confidentialité : bon ça reste entre nous ! C'est pas comme si y avait des gens qui regardent.
Bon, bref, c'est bon, vous avez compris.
Il a compris.
Bon ben signez.

Bon alors on ne va pas vous mener au décès, hein ! Ca fait des histoires avec les parents.

Très bien. Donc maintenant vous allez nous remettre votre portable.
Asseyez-vous.

Poul
Tension
Température
Prélèvement buccal
Activité électrodermale (ça va nous indiquer votre niveau de stress)
On le scotche pour qu'il ne bouge pas.
Prélèvement de sang
C'est pas éthique, il est mineur !
Ben j'ai pris le sang de celui d'avant.
Oui ben justement.
Oh la la…

Analyse d'urine

Ah ça non !

Comme on ne va pas pouvoir attendre que votre téléphone se décharge, nous allons créer une panne majeure – importante – majeure ! et relever à nouveau les constantes.

(il pète le téléphone au marteau)

Elle
On avait dit majeur mais réversible.

Lui
Ah ben là, c'est majeur !
Elle
Mais réversible !

Lui
Ah bah oui mais réversible, fallait le dire.

Elle
Ah bah voyez dans quel état il est.

Lui
C'est qu'un objet, c'est remplaçable.
Ah la la, le niveau de stress monte, tenez tenez tenez… (ils lui rendent son portable) Le voilà.

Bon ben merci beaucoup de votre participation : beau spécimen. Tempérament. Il était solide. Bonne constitution.

Elle
Ce genre d'expérience met en évidence le fossé qui sépare cette génération de la nôtre.
Ce qui nous amène à la question suivante de notre étude :

Lui
Manifestement, une incompréhension voire une incommunicabilité existe entre le vieux et le jeune.

Elle
Est-ce un phénomène nouveau, lié aux nouvelles technologies, ou en a-t-il toujours été ainsi ? Observons donc notre Vieux, lorsqu'il était lui-même jeune, à l'époque.

2ème tableau

Lui
Bon, alors pour être cool, je… Le col, les épaules, La mèche, le soleil dans les yeux.
Maman ! Maman ! Maman !!

Elle
Tu m'as appelé mon chéri ? (elle l'arrange)

Lui
Oui, euh en fait, c'est…

Elle
Tu veux manger quelque chose ? Je te prépare du pain avec du chocolat ?

Lui
Non, ça va…

Elle
Tu veux du fromage ?

Lui
Quoi, euh, non non…

Elle
Tu veux que je te fasse des crêpes ? Des bonnes crêpes au sucre.

Lui
Non, non… Ah putain !

Elle
Ah non ! Pas de gros mots dans ma maison, bordel de merde.
Sinon, il reste des cookies…

Lui
J'ai pas faim !

Elle
T'as pas faim… Tu veux un petit jus de fruit ?

Lui
Non ! Non…

Elle
Je te fais un petit thé ?

Lui
Non merci, ça va…

Elle
Bon alors un verre de lait ?

Lui
Non, j'ai pas soif !

Elle
T'as pas soif. T'as pas faim t'as pas soif. T'es malade ? (elle met sa main sur son front et sur le sien à elle.) Tire la langue. Tire la langue ! Non, c'est pas ça… T'as des problèmes de transits ?

Lui
Hein ?

Elle
T'as des gaz ? T'es constipé ?

Lui
Oh, mais ça va pas, arrête !

Elle
Mais c'est la nature ! Tu fais caca mou ?

Lui
M'enfin, maman !!

Elle
T'as, pas faim, t'as pas soif, t'es pas malade. Oh, ça y est, je sais ! T'es amoureux ! Comment elle s'appelle ?

Lui
Qui ?

Elle
Ben la fille !

Lui
Mais y a pas de fille !

Elle
Y a pas de fille ? Tu sais, tu peux me parler, je suis très ouverte d'esprit. C'est un garçon ?

Lui
Mais qui ?

Elle
Ton amoureux.

Lui
Mais non ! Y a pas d'amoureux ! Oh mais arrête !

Elle
Tu me parles gentiment. Je suis ta mère. Tu me respectes. Je ne veux pas entendre ça dans ma maison.
Bon mais dis moi alors ! Pourquoi tu m'appelles.

Lui
Oui, ben oui, justement ! Je me suis inscrit à l'école pour faire des sciences de scientifiques.

Elle
Je comprends pas.
L'école de science de scientifique ?
Qu'est-ce que c'est que cette histoire ? Qu'est-ce que c'est que cette lubie.
Scientifique, c'est pas un métier, c'est pas sérieux.
On avait dit quoi, on avait dit quoi ?
On avait dit licence de star internationale. On avait dit une formation, une colonne vertébrale professionnelle. Quelque chose qui t'emmène quelque part. Des cours de danse, de chant. Un métier sérieux, où tu gagnes ta vie correctement.

In this page, the 2 comedians switch the positive stereotypes that youngsters often have for "famous people" into negative stereotypes. Raphaël says that being famous and international is so boring, etc

Lui
J'ai déjà mon bac de star international.

Elle
Ben oui c'est très bien. C'est qu'un début.

Lui
Moi j'aime pas.
Gym de star,
Danse 6, 7 et 8…
Faut à aller la télé, mon album de la maturité. Concert à Toronto… After à Los Angeles…
Et les filles elles sont là ! Haaaaa, star internationale ! Elles t'arrachent ta chemise.
Mais moi je l'aime ma chemise, je veux la garder ma chemise.

Elle
On fait pas toujours ce qu'on veut dans la vie. La science, tu pourras toujours en faire le week-end.

In these pages, Raphaël makes a monologue about how science can be interesting, magic, wonderful and absolutely fascinating

Elle
Scientifique, pourquoi pas pilote ou architecte pendant que tu y es. C'est pas un métier, tu seras mal coiffé, mal habillé, t'auras pas d'amis, que des collègues. Y aura pas de filles.

Lui
Ah si y a des filles !

Elle
Ha ! Des femmes à barbe, oui ! Tu parleras un langage obscurantiste que personne comprendra, sauf les cinq collègues qui feront la même recherche que toi. Tu sauras presque tout sur presque rien. Tu vas passer ta vie à chercher chercher chercher des trucs que tu trouveras jamais. Les scientifiques sont malheureux, c'est scientifiquement prouvé. Alors c'est ça ton projet dans la vie, torturer des souris. Tu veux ressembler à ce scientifique, là, avec des cheveux blancs qui tire la langue tout le temps.

Lui
Einstein ! Oh quand même, non, lui c'est pffiuuu…

Elle
Il a pas l'air bien, ce monsieur tu sais, il doit avoir des problèmes sychologiques. C'est quand même pas ça ton idole ? C'est pas à ça que tu veux ressembler ?

Lui
Oh… Non, tout de même pas… Enfin peut-être plus tard…
Moi j'ai envie de… Le sol. Les plantes, les fourmis. Le ciel avec Pif paf paf (étoiles qui apparaissent) les étoiles. Messages entre l'arbre et les étoiles. Le mécanisme de la marche. L'intérieur du corps, la digestion, ce que ça te fais dans la tête, et ce que ça fait à la maman dans la tête. Ca grouille ! Y a un monde là-dedans !! Où ils sont ? Les liens entre les choses.
Y faut que je sache.

In this monologue, Raphaël explains that science is everywhere : In the stars, in the body, in the trees, everywhere, everywhere. And that he wants to undestand and research a lot of things, even if they don't seem really useful.

Oui, enfin en résumé.

Tu veux un petit chocolat chaud ?
Oui

2ème exposé

Lui
Voilà.

Elle
Voilà.

Elle
Vous m'avez vraiment… wahou. Vous avez pris des cours de théâtre ?

Lui
Oh comme ça… Non… Il y a longtemps… Au CM2. J'ai fait un spectacle… La Belle au bois dormant.

Elle
Vous faisiez le Prince ?

Lui
Non… Le cheval. Et ensuite une des trois marraines.
Quelle conclusion tirer de la scène que nous venons d'observer ?

Elle
Et bien, cette incompréhension dans les rapports jeune-vieux était la même lorsque

notre vieux était lui-même jeune.

Lui
Plongeons maintenant à l'intérieur du jeune de l'époque, et voyons quelles sont ses réelles préoccupations.

Elle
Obsessions.

Lui
Préoccupations.

3ème tableau

Elle
Pssst
Psst

Lui
Ecoutez vous êtes grotesques. On sait très bien que c'est vous.

Elle
Je suis coincée.

Lui
Ah non, ne dites pas ça, je vous trouve très bien.

Elle
Je suis coincée !

Lui (il comprend)
Ah ! (Il l'aide)

Lui
Ben moi ma préoccupation, c'est Julie. Julie, elle est au club de science.
Ce soir y a une fête je sais que Julie y sera, ce soir j'ai décidé de tenter ma chance. Ce soir, je me lance.

Elle
Ce soir, j'ai enfin le droit d'aller en soirée.

Lui
Il faut être présent mais pas envahissant

Elle
Je dois être intelligente, mais pas intello

Lui
Intéressé, mais pas avide

Elle
Jolie mais pas vulgaire

Lui
Que j'ai du désir mais pas la bave aux lèvres.

Elle
Sympa, mais pas open bar.

Lui
Mais surtout, le plus important,

Elle
Mais surtout, le plus important,

Elle et lui
Faut qu'j'ai l'air… cooool !

(danse.)

3ème exposé

Voilà.
Voilà.
Voilà.
Voilà.
(Elle fait mine d'enlever ses chaussures.)

Lui
Ah non, c'est dommage, j'aimais bien.

Elle
Ah ? (elle les garde).

Lui
Au cœur de la préoccupation du jeune, c'est la rencontre. Enfin ça le démange, quoi.

Elle
Certains éléments favorisent ce rapprochement des corps. 1.

Lui
Une semi-obscurité, qui démultiplie les sensations olfactives.

Elle
2.

Lui
Une ambiance sonore limitant la communication verbale

Elle
3.

Lui
Le printemps, saison propice par excellence, avec les fleurs qui s'ouvrent, exposant ainsi à la vue de tous leurs organes reproducteurs.

Le jeune, en recherche consciente ou inconsciente d'un partenaire exhale pour tous les pores de sa peau des phéromones en grande quantité.
Dans le même temps, il perçoit les phéromones émises autour de lui, jusqu'au moment où paf
Pif
Boum
Il y a compatibilité.

C'est un feu d'artifice d'hormones et d'émotions: androsténole, copuline, phénylétylamine, occitocine, dopamine, endorphine. Spermine…

Elle
Toutes ces observations nous mènent à la conclusion suivante :
Le vieux ne peut pas comprendre le jeune, car il est dégagé de ces pulsions, Il est libéré

Lui
délivré

Lui
Il n'est plus traversé par ces obsessions de contact, de frôlement, de friction, de frottement…

Elle
El contacto físico, la fricción…

Lui
Bien, nous allons, notre présentation est maintenant terminée,

Elle
C'est terminé.

Lui
Nous allons maintenant nous isoler en coulisse enfin, je vais maintenant me retirer…

Elle
Déjà ?

Lui
Enfin non non, nous allons prendre congé…

Elle
Oh oui, partons.

Lui
Tous les deux ? En voyage !

Elle
Madrid, Séville… Buenos Aires…

Lui
Et en rentrant, on pourrait prendre un petit appartement…

Elle
Un appartement ensemble !

Lui
Je vous présenterai mes organes reproducteurs.

Elle
Et moi je vous présenterai mes parents.

Lui
Heu, oui alors il faudrait s'organiser pour pas qu'ils se croisent.

Elle
Vous savez ce qui me plairait ?

Lui
Non ?

Elle
Ce serait qu'on prenne un petit chien ensemble.

Lui
Ah euh oui. Ou alors un jeune.

Elle
Un jeune qu'on ferait nous même ! A la main.

Lui
Oh oui ! Enfin à la main…

Elle
Bio, quoi.

Lui
Et on l'appellerait Poussin.

Elle
Ah non, pas Poussin. Il faudrait pas qu'il soit comme… Il faudrait faire en sorte qu'il soit… Beau comme son papa.

Lui
Intelligent comme sa maman.

Elle
Grand comme… enfin brun.

Lui
Les yeux de sa maman, ou les yeux du jeune de tout à l'heure.

In this part, the 2 comedians are discussing about choosing the features of their baby, as if they were (and scientists too) God. But as it's really ironic, the audience completely understands that eugenics is really negative. And it may not be possible in real life.

Oh oui. Et quel tempérament ! Vous vous rappelez quand on lui a cassé son…

Moi je ne suis pas prêt à mettre au monde un jeune dont la vie serait suspendue à la moindre panne de batterie.

Mais vous inquiétez pas, je l'opérerai à la naissance, je lui mettrai une batterie intégrée dans la jambe.

Oh, comme vous êtes brillant, quel esprit.

Ah oui mais attendez, il faudrait que la batterie soit chargée en permanence !

Mais ne vous inquiétez pas, on lui installera un système à énergie kinétique qui convertira les mouvements de la marche en électricité !

Mais on aura un problème connectique, il faudrait lui carrer un port USB quelque part sur le corps.

Mais non, on pourra se servir de l'induction, comme ça il suffira qu'il mette son portable dans une poche et ça se rechargera tout seul.

Mais ça on est capable de le faire tout de suite ?

Oui, il y a encore quelques améliorations à apporter, mais c'est une question de temps.

Mais moi j'ai envie tout de suite…

Oh, patience, tout de même !

Mais on va pas mettre au monde un enfant pour qu'il ait des problèmes de batterie quand il sera grand ! C'est pas éthique. Moi je ne veux pas d'un enfant qui souffre !

On lui implantera une batterie à la naissance, un coup de bistouri et hop.

Lui
Avec la science, on doit bien pouvoir bidouiller quelque chose !
(voyant le public) Oh !

Elle
Je connais un excellent généticien…

ANNEX 3: QUALIA SYSTEM RESULTS ANALYSIS

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Introduction

This report presents findings from testing of the pilot performances generated after focus groups with students conducted for the PERFORM project (perform-research.eu). The performances were tested with a sample of students from 10 to 16 secondary schools in each case study. These performances were expected to be effective tools to generate a two-way dialogue between students and the researchers during the performance, and to prompt student reflections about researchers as role models, gender inequalities and ethical issues in STEM careers and scientific research.

The results presented here show evidence of impact in the direction expected from these performances, with improvements in young people's identification with science and their self-assessments of their ability to take on a scientific career. On the measure of general pro-science attitudes included in the survey- level of agreement with the idea that the benefits of science outweigh its risks- there was no effect. This indicates that the performances evaluated in this study are supporting the aspirations of young people, but not limiting their inclination to critically assess the relative benefits and risks of scientific development for themselves. This is in keeping with the aims of the PERFORM project, which seeks to support Responsible Research and Innovation values by encouraging the self-efficacy of students to engage with science and its implications.

Background about the project

'PERFORM aims to investigate the effects of the use of innovative science education methods based on performing arts in fostering young peoples' motivations and engagement with science, technology, engineering, and mathematics (STEM) in selected secondary schools in France, Spain and the United Kingdom. In doing that, PERFORM takes action to overcome the remaining distance between young people and science and to break the unidirectional model of scientific knowledge transfer.

The project explores a creative, participatory educational process on STEM through the use of scenic arts with secondary school students, their teachers and early career researchers, who get actively involved in experiencing science. Students also reflect on their own role in the interaction between science and society, and the values embedded in Responsible Research and Innovation (RRI). PERFORM analyses how such human-centred, science-arts educational approach contributes to foster girls' and boys' motivations towards science learning and strengthen the transversal competences they will need for STEM careers and jobs. The education and communication skills required for teachers and researchers to further replicate the educational process are also explored and addressed in specific training toolkits.'

Methods

To evaluate the impact of the performances delivered to young people by project partners in the PERFORM project, a repeated measures impact evaluation study was developed. This was delivered using a survey design that was prepared by Eric Jensen (University of Warwick), drawing on previous research he has done on young people's engagement with science. This survey design was provided to project partners for feedback and updating. The survey was translated into Spanish by The TBVT Theory and administered in both English (in UK) and Spanish (in Spain).

The survey was placed online, and administered by teachers in computer labs in schools. The survey combines Likert scales with some open-ended items. The estimated time required to complete each survey was up to 10 minutes. In fact, the completion time for the pre-visit survey ranged from 1 minute and 12 seconds to 9 minutes and 50 seconds. The post-visit survey completion time was estimated at up to 15 minutes. It turned out that it took a minimum of 1 minute, 52 seconds and a maximum of 16 minutes, 48 seconds.

Main objectives of the survey

- Explore perceptions and attitudes of student audiences towards the PERSEIA (enjoyment, interest, value, competence).

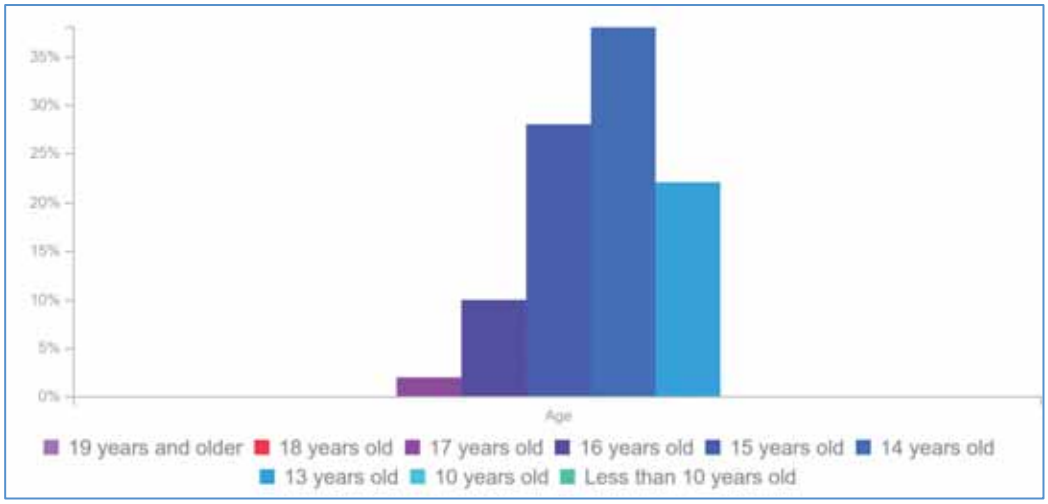
- Explore whether the performances are able to generate a two-way dialogue between students and researchers and stimulate students' reflections about the different topics PERSEIAs aim to include (i.e., those addressed during previous focus groups: gender inequality and girl's barriers in STEM; science-related stereotypes; two-way dialogue between scientists and the society; ethical issues in scientific research; the role of entrepreneurial and multidisciplinary research careers in labour market).

These objectives were addressed with the survey design, using a combination of open- and closed-ended survey items.

Sample

There were 667 respondents, split almost equally between boys (n = 327) and girls (n = 333). The media age of respondents was 14, with a range from 13-18.

Figure 1: Age range of participants



More than half of respondents (53%) had visited a science museum in the previous 12 months.

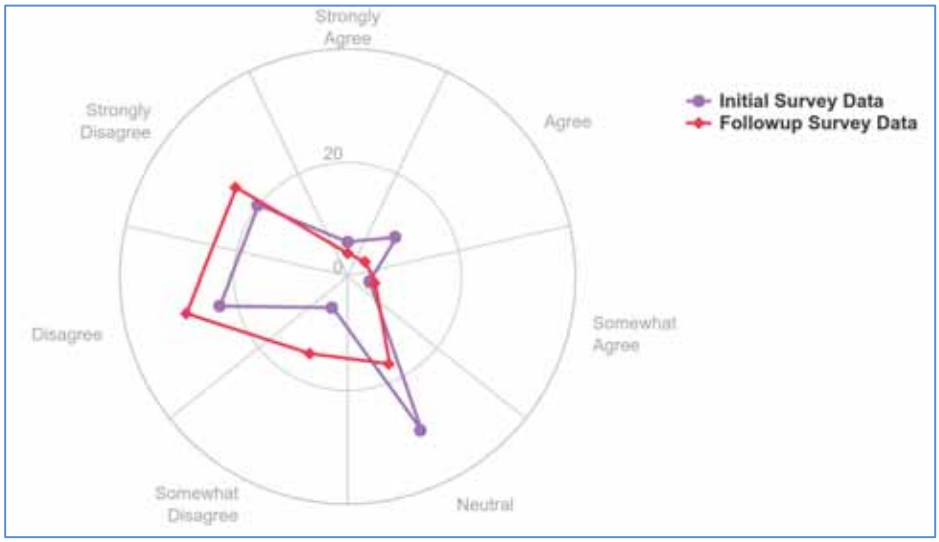
Results

The analysis of the data collected for this evaluation has focused on the closed-ended survey items.

Relevance of science to young people's lives

There was evidence of impact on respondents' assessment of how relevant science is to their lives (n = 145; X2=654). The level of disagreement with the statement 'Science is irrelevant to my life' increased significantly from pre-visit to post-visit. This included a shift in 'somewhat disagree' responses (6% initial against 15% follow-up), 'disagree' responses (23% initial compared to 29% follow-up) and 'strongly disagree' responses (20% initial against 25% follow-up). Most of this shift came from respondents being less likely to answer 'neutral' (30% initial versus 17% follow-up).

Figure 2: Impact metric comparing level of agreement with statement 'Science is irrelevant to my life' from pre-visit to post-visit survey

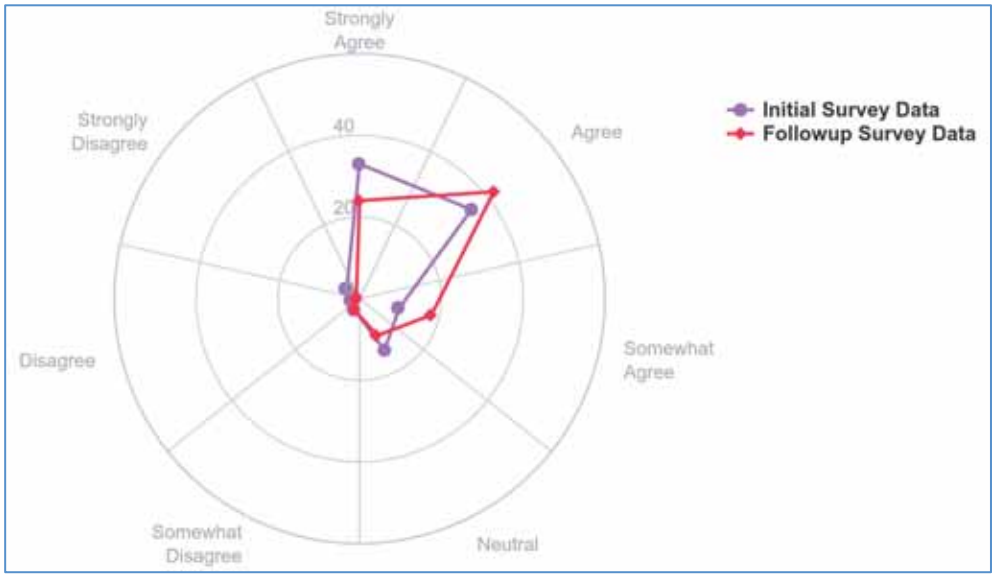


There was no evidence of a gender difference in responses to this level of agreement statement.

View of science's role in addressing world problems

The level of agreement with the statement "Science helps to solve the world's problems" significantly increased from pre-performance to post-performance amongst those who did not already 'strongly agree' before the performances live (n = 141; X^2=1239).

Figure 3: Change from pre- to post-performance in level of agreement with the idea that "Science helps to solve the world's problems"



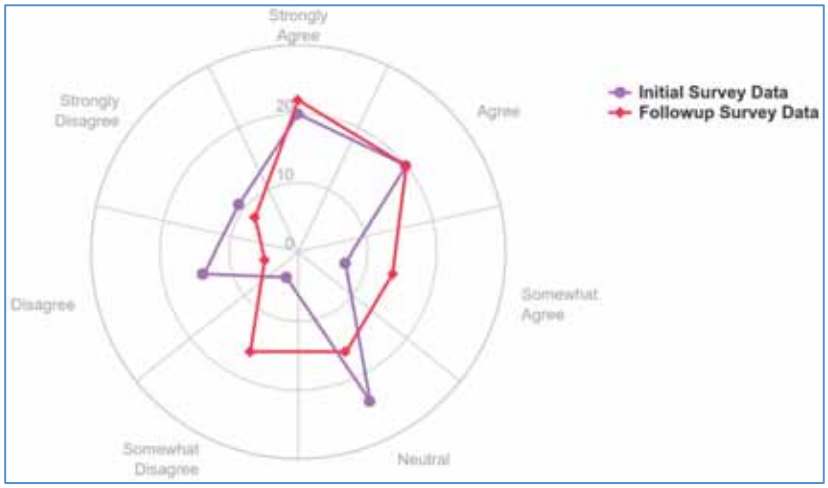
Interestingly, 9% of those who had 'strongly agreed' before the performance dropped this strong viewpoint to a more moderated position.

There was a gender difference in responses on this item in the pre-visit data. Male respondents were more likely to 'strongly agree' with the statement "Science helps to solve the world's problems" than female respondents (37% against 29%).

Perception that scientific knowledge will affect career opportunities

There was evidence of impact among those that initially disagreed with the statement 'Scientific knowledge is important to my future career' (n =140; X^2=754). The proportion of 'disagree' and 'strongly disagree' responses decreased from a combined 25% before the performance to a combined 13% post-performance.

Figure 4: Change from pre- to post-performance in level of agreement with the idea that "Scientific Knowledge is important for my future career"



Most of the change meant that respondents' perception of scientific knowledge as important for their future career plans shifted towards more moderate positions, with 'somewhat disagree' increasing from 4% pre-performance to 16% afterwards and 'somewhat agree' increasing from 7% to 14%. There were no changes in the number of people with a prior strong perception that scientific knowledge will be important for their careers.

There was evidence for a gender difference in pre-performance responses. Female respondents were somewhat more likely to 'strongly agree' when presented with the statement 'Scientific knowledge is important to my future career' than male respondents (23% and 17%, respectively).

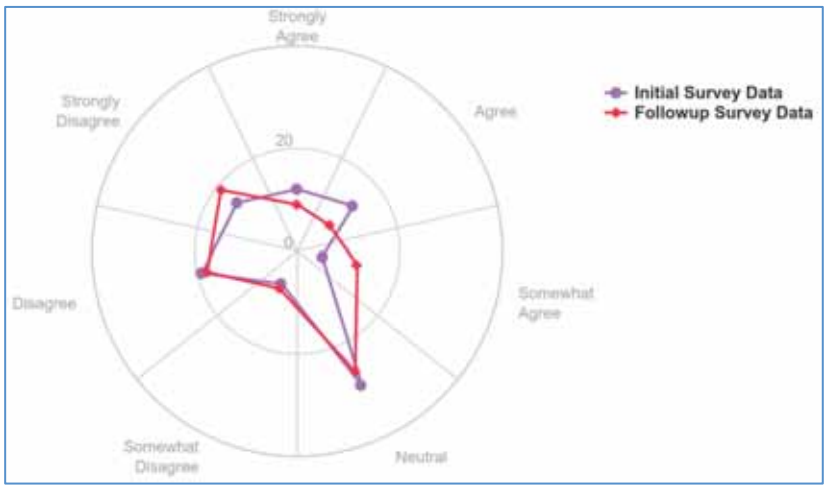
Science identity

Impact on participants' science identity was measured by asking for their level of agreement with the statement, 'Science is not for me'. Results showed a significant move in the direction of greater identification with science, and reductions in

rejections of science identity (n =140; X^2=1090).

The number of responses in agreement and strong agreement declined after the event (14% before to 8% after and 12% to 9%, respectively). More respondents took a more moderate science identity position by answering 'somewhat agree' (5% pre-performance against 12% post-performance). There was also an increase in the number of people responding in strong disagreement with the statement (15% pre-performance and 19% post-performance).

Figure 5: Impact metric comparing level of agreement with statement 'Science not for me' from pre-visit to post-visit survey



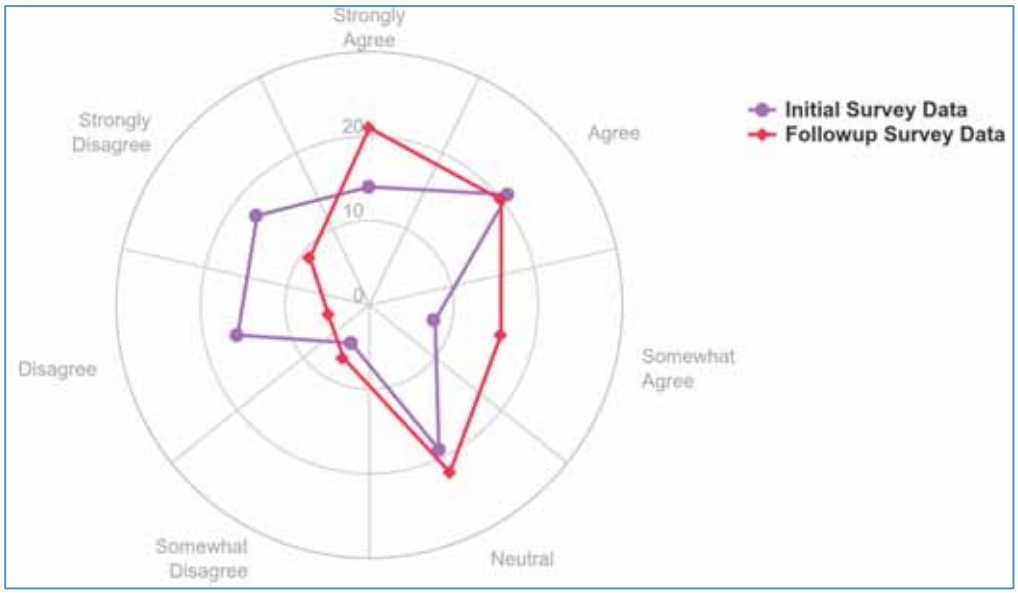
There was no evidence of a gender difference in responses to this level of agreement statement.

Scientific career self-efficacy

There was evidence of impact on respondents' perceptions of their capabilities pertaining to taking on a scientific career, as measured by the Likert scale statement 'If I wanted to, I could be a scientist' (n = 139; X2= 696). The level of

disagreement with this statement decreased significantly from pre-visit to post-visit. This included a shift in 'disagree' responses (16% initial against 5% follow-up) and 'strongly disagree' responses (17% before compared to 9% after event). The changes came from respondents being more likely to answer 'strongly agree' (14% initial versus 21% follow-up) and 'somewhat agree' (8% pre- and 16% post-visit).

Figure 6: Impact measure in level of agreement with the statement 'If I wanted to, I could be a scientist' as a change from pre- to post-performance



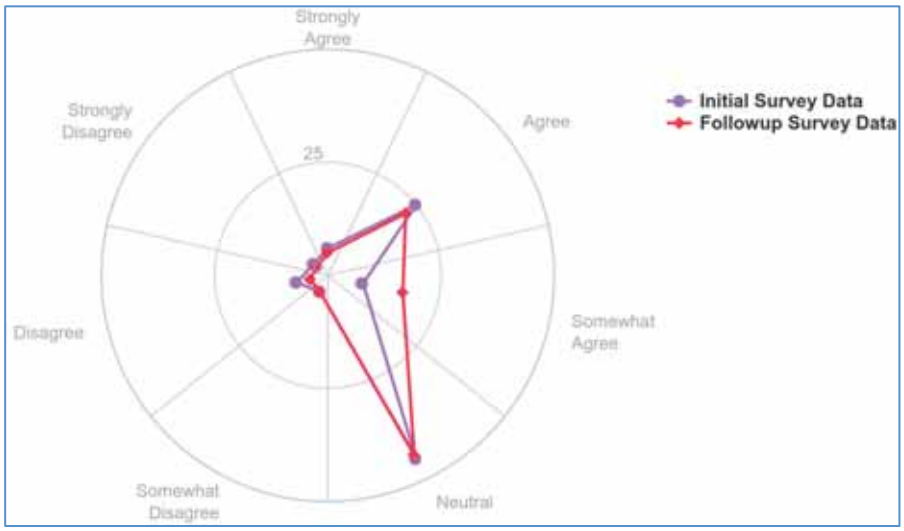
The female participants were less likely to indicate that they could be scientists, with data from the pre-performance survey showing female participants more likely to answer 'disagree' (19% against 14%) and more likely to answer 'strongly disagree' than males (18% compared to 15%). In comparison, male respondents gave more 'neutral' responses than females (23% to 16%).

Views on risks and benefits of science

There was no a significant impact on participants' opinions about whether the

benefits of science outweigh its risks, as measured by the Likert scale statement: 'The benefits of science always outweighs its risks' (n = 139; X^2= 668). Almost half of the participants had a neutral view on the subject prior to the performance, which continued to be the case after the event (45%-44%). Stances both in agreement and disagreement with the idea decreased very lightly in favor of an increase on the 'somewhat agree' responses from 8% before the event to 17% after.

Figure 7: Change from pre- to post-event in level of agreement with "The benefits of science always outweigh its risks"



There was no evidence of a gender difference in responses to this statement.

Acknowledgements

Eric Kennedy (Arizona State University) contributed to the survey design used for this report. TBVT offered feedback and suggestions, as well as translating the survey into Spanish and ensuring the administration of the survey data collection. Isabel Ruiz also offered feedback on the survey design.

ANNEX 4 EX-ANTE AND EX-POST QUESTIONNAIRES

1- Survey Before Performing Activity

This survey is being done for PERFORM European Project. We would be very interested to learn your views. Your responses will be kept confidential and used for research purposes only. This is not a test and will not be used for school assessment.

Personal information

1. **Name of school**

_____

2. **Gender:**
   Mark only one oval.

   ◯ Female
   ◯ Male

3. **Age**
   Mark only one oval.

   ◯ 12
   ◯ 13
   ◯ 14
   ◯ 15
   ◯ 16
   ◯ Other: _____

4. **What comes to mind when you think of 'science'?**

_____

_____

_____

_____

_____

5. **What comes to mind when you think of a 'scientist'?**

_____

_____

_____

_____

_____

Do you agree with the following statements?

6. **Science helps to solve the world's problems**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

7. **Name three examples of world's problems that science is actually solving**

   _____

8. **Science is not for me**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

9. **Science is irrelevant to my life**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

10. **Scientific knowledge is important for my future career**
    Mark only one oval.

    - strongly agree
    - agree
    - neutral
    - disagree
    - strongly disagree
    - Don't know / no opinion

11. **Science is usually boring**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

12. **If I wanted to, I could be a scientist**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

Please, write down your opinion about

13. **What comes to mind when you think of a ‘male scientist’?**

Do you agree with the following statements?

14. **Do you know someone who works in science?**
Mark only one oval.

- Yes
- No
- Unsure

15. **Write the names of five scientists. Try to think of at least two of them that are currently doing science**

16. **Scientists follow ethical standards to pursue their studies.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

17. **Ethical standards are essential to pursue scientific research, such as improving the environment, the rights of laboratory animals or the quality of human beings.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

18. **People who are not working in science, like you or your friends, can participate in scientific projects.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

19. **Name a scientific project that people who are not scientists can participate in**

Who do you think would do best the following jobs?

20. **Astronomer**
Mark only one oval.

- Male
- Female
- Either

21. **Engineer of bridges and roads**
Mark only one oval.

- Male
- Female
- Either

22. **Vet**
Mark only one oval.

- Male
- Female
- Either

23. **Computer programmer**
Mark only one oval.

- Male
- Female
- Either

24. **Nurse**
Mark only one oval.

- Male
- Female
- Either

25. **Theoretical physicist**
Mark only one oval.

- Male
- Female
- Either

Please, write down your opinion about

26. **What comes to mind when you think of a 'female scientist'?**

Thank you very much for completing this survey. You will be asked to complete one more survey after an upcoming performance event at your school.

2- Survey After Performing Activity

This survey is being done for PERFORM European Project. We would be very interested to learn your views. Your responses will be kept confidential and used for research purposes only. This is not a test and will not be used for school assessment.

Personal information

1. **Name of school**

_____

2. **Gender:**
   Mark only one oval.

   ◯ Female
   ◯ Male

3. **Age**
   Mark only one oval.

   ◯ 12
   ◯ 13
   ◯ 14
   ◯ 15
   ◯ 16
   ◯ Other: _____

4. **What comes to mind when you think of ‘science’?**

_____

_____

_____

_____

_____

5. **What comes to mind when you think of a ‘scientist’?**

_____

_____

_____

_____

_____

Do you agree with the following statements?

6. **Science helps to solve the world's problems**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

7. **Name three examples of world's problems that science is actually solving**

   _____

8. **Science is not for me**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

9. **Science is irrelevant to my life**
   Mark only one oval.

   - strongly agree
   - agree
   - neutral
   - disagree
   - strongly disagree
   - Don't know / no opinion

10. **Scientific knowledge is important for my future career**
    Mark only one oval.

    - strongly agree
    - agree
    - neutral
    - disagree
    - strongly disagree
    - Don't know / no opinion

11. **Science is usually boring**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

12. **If I wanted to, I could be a scientist**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

Please, write down your opinion about

13. **What comes to mind when you think of a ‘male scientist’?**

Do you agree with the following statements?

14. **Do you know someone who works in science?**
Mark only one oval.

- Yes
- No
- Unsure

15. **Write the names of five scientists. Try to think of at least two of them that are currently doing science.**

16. **Scientists follow ethical standards to pursue their studies.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

17. **Ethical standards are essential to pursue scientific research, such as improving the environment, the rights of laboratory animals or the quality of human beings.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

18. **People who are not working in science, like you or your friends, can participate in scientific projects.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

19. **Name a scientific project that people who are not scientists can participate in**

Who do you think would do best the following jobs?

20. **Astronomer**
Mark only one oval.

- Male
- Female
- Either

21. **Engineer of bridges and roads**
Mark only one oval.

- Male
- Female
- Either

22. **Vet**
Mark only one oval.

- Male
- Female
- Either

23. **Computer programmer**
Mark only one oval.

- Male
- Female
- Either

24. **Nurse**
Mark only one oval.

- Male
- Female
- Either

25. **Theoretical physicist**
Mark only one oval.

- Male
- Female
- Either

Please, write down your opinion about

26. **What comes to mind when you think of a 'female scientist'?**

We would now like to ask you some questions about the performance event you recently went to at school:

27. **Please describe the performance event you attended in your own words.**

28. **What, if anything, do you feel you gained from the performance?**

29. **What, if anything, do you feel you learned from the performance?**

Do you agree with the following statements?

30. **The performance was boring.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

31. **I enjoyed the performance.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

32. **The performance was confusing.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

33. **The performance was a waste of time.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

34. **I think this performance event is important for my scientific learning.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

35. **The performers are scientific experts.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

36. **I trust the scientific information in the performance I attended.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

37. **What, if anything, did you like about this performance?**

38. **What, if anything, did you dislike about this performance?**

39. **I actively participated in the performance event.**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

40. **Did you talk to any of the performers during the event?**
Mark only one oval.

- Yes
- No
- Unsure

41. **The time conversing with performers was useful and/or interesting**
Mark only one oval.

- strongly agree
- agree
- neutral
- disagree
- strongly disagree
- Don’t know / no opinion

42. **Did you enjoy the use of social networks to interact with the performers?**
Mark only one oval.

- Yes, I also follow them in Twitter/Instagram
- Yes
- Neutral
- No
- No, it was a waste of time

Thank you very much for completing this and the previous survey. Your responses will be very helpful for understanding the views of people like you, and for evaluating the performance event you attended.

ANNEX 5 PERFORMERS' STRUCTURED INTERVIEW SCRIPT

Next questions have been elaborated to include in the assessment of the PERSEIAs generated by the professional science communicators SMS, TRACES and TBVT during PERFORM project.

You should answer this survey after the round of PERSEIAs delivery. Each performer should fill one questioner.
Please, notice that question 8 should be answered at the end of all the sessions

Case study:

1. Which elements of the performance worked best?

2. Why did these elements work well?

3. Can we make any general points on why these elements work that would help in developing a toolkit of advice on PERSEIAs?

4. Which elements did not engage the audience so well?

5. Why do you think they did not work so well?

6. What changes can you suggest to improve these elements that didn't work so well?

7. Are there any general points on what NOT to do from this experience that would be useful for the toolkit of advice on PERSEIA?

8. At the end of the session and before you pack away, try and write down 3 positive and 3 negative immediate thoughts about the session.