Deliverable D2.2
Final protocol of tested methods to generate a transformative participatory educational process by using science and arts-based education approaches

Project acronym:
PERFORM

Project Title:
Participatory Engagement with Scientific and Technological Research through Performance

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SUMMARY

This deliverable corresponds to the task 2.2. "*Participatory process with young people, teachers and early career researchers*", which aimed at conducting a participatory educational process involving secondary school students, their teachers, and early career researchers, in order to guide students in the design and execution of their own *Performance-based Science Education and Innovative Activities* (PERSEIAs), following the methodological protocol generated in the previous task 2.1. To achieve it, a series of participatory workshops were carried out in selected secondary schools of Spain, France, and the UK. A total of 253 students, 30 teachers, and 44 early career researchers were engaged in several mutual learning scenarios that (1) promoted the direct interaction between scientific and educational communities; (2) manifested the human dimension of science and the values embedded in the Responsible Research and Innovation (RRI) approach; (3) provided students with transversal competences related to Science, Technology, Engineering, and Mathematics (STEM) careers; (4) and supported students in the creation of their own PERSEIAs. The participatory workshops were designed and adapted to specific local contexts by the science communication partners of the project, who used three different performing arts to create the PERSEIAs: stand-up comedy by The Big Van Theory (TBVT) in Spain; science busking by Science Made Simple (SMS) in the UK, and clown based on improvisational theatre by TRACES in France. The resulting participatory process involving students, teachers, early career researchers, and science communicators/performers has been proven useful as a tool to lead students to the development of their own PERSEIAs, as well as to empower them as agents to engage and to motivate other youngsters to approach STEM.

1. INTRODUCTION

A considerable percentage of young people in Europe are not interested in Science, Technology, Engineering and Mathematics (STEM) careers. The international study on "Social Perception of Science" conducted by the BBVA Foundation (2012) reported that, on average, the percentage of people who admitted having in mind to study a scientific career was 16.9% in Europe compared to the 32.6% in the United Sates. Among the European countries, this percentage ranged from 31% in the Netherlands to 7.1% in the Czech Republic. In relation to the countries we focused on for our study, the values varied from 25.2% in the UK to 18.8% in France or 16.4% in Spain.

In the last decades, numerous studies have identified some of the reasons behind young's people discouragement with STEM careers, such as a stereotypical image of scientists (Steinke et al., 2007; Ruiz-Mallén & Escalas, 2012), a self-perceived lack of skills for STEM careers (Gallup Organisation, 2008), in particular among girls, or the irrelevance or inapplicability of the STEM curriculum to students' reality and future career paths (National Foundation for Educational Research, 2011). Such negative perceptions may discourage adolescents from learning about science and technology, as well as undervaluing the role of science in society. Indeed, since the beginning of this century, authors alerted to the decline of the scientific vocations in the European context (European Commission, 2001; Convert & Gugenheim, 2005; Rocard, Csermely, Jorde, Lenzen, Walwerg, & Hemmo, 2007; Organisation for Economic Cooperation and Development, 2008). Jenkins and Nelson (2005), for instance, 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 tackle the disengagement of secondary school students towards science learning and STEM careers, by supporting their engagement in and understanding of STEM issues through the use of innovative methods based on performing arts in formal education settings. Moreover, PERFORM intends for addressing the challenge of promoting scientific and technical vocations of girls and boys, a key point in the European agenda, in order to avoid loss of scientific talent and to ensure future innovation capability, excellence and competitiveness. Finally, PERFORM seeks to incorporate some of the values framed within the Responsible Research and Innovation (RRI) approach in students' engagement in STEM (e.g. introducing gender perspectives or ethical issues in science research).

The European framework for RRI seeks to align research and innovation with broader social values by engaging all societal actors (i.e. researchers and innovators, educators, civil society organisations, and policy-makers) to produce ethically acceptable and socially desirable research and innovation outcomes that tackle societal challenges. To do that, RRI embraces six key agendas: science education, public engagement, gender equality, ethics, open access, and governance. Accordingly, the research conducted in PERFORM connects with RRI as for being a research project into science education tackling with gender equality, ethics, and public engagement issues.

For these purposes, PERFORM has designed a novel approach in formal education, that is, a participatory human-centred educational methodology based on performing arts that promotes an active interaction and collaboration between secondary school students, their teachers, Early Career Researchers (ERCs), and professional science communicators and performers. This innovative methodology has been tested in selected schools in Spain, the UK, and France.

Based on Mezirow's (1997) transformative learning theory, the development of PERFORM's participatory process aims at changing students' frames of reference associated with STEM careers, promoting critical thinking and self-reflection related to some of the RRI values (e.g. gender and ethical issues), incorporating performing skills into science learning, as well as generating new discursive and dialogical paths of understanding STEM, in order to increase their engagement in science learning. To do that, PERFORM team has combined two different but intertwined approaches: drama-based educational activities and participatory educational processes. On the one hand, as stated by Nicholson (2005), drama-based educational activities have the potential to foster participatory, dialogic and dialectic skills of young students, providing a rich source of individual and collective experimentation. In this line, the study carried out by Abed (2016) showed that drama-based teaching in scientific subjects led secondary students to a better understanding of science concepts and improved their attitudes towards science learning. On the other hand, participatory educational processes can facilitate direct interaction and build relationships inside and outside school between the different actors involved in the process (i.e. students, teachers, science communicators/performers and researchers), as a mean for linking young people with real science. Our participatory approach is grounded on interactive participation and self-mobilization (Pretty, 1995), in which students, teachers, science communicators/performers and early career researchers, are actively involved in the development of educational activities that entails active thinking and hands-on learning connected to 'real world' situations.

This document presents the Deliverable 2.2 consisting of a protocol of tested methods to generate PERSEIAs through a participatory educational process, resulting from the activities developed in the task 2.2 of the project, which constitutes the logical continuation of task 2.1 from which the document D2.1 "Final protocol of tested methods to transform a performance-based activity into a PERSEIA" emerged. In task 2.1, the PERFORM consortium, through the guidance of their science communication partners (TBVT in Spain, SMS in the UK, and TRACES in France), built a methodological protocol that adapted performance-based activities (stand-up comedy, science busking, and clown based on improvisational theatre, respectively) to generate *PERformance-based Science Education Innovative Activities* (PERSEIAs). Next, task 2.2 aims at designing and conducting a transformational and participatory process by which secondary school students, with the participation of their teachers and early career researchers, generated and performed their own PERSEIAs in their schools, becoming thus agents to engage and motivate other youngsters to approach STEM.

The following chapter summarises the general and specific objectives of this document. Chapter 3 presents the methodology followed and the stakeholders involved in this participatory process for producing the protocol. Next, Chapter 4 contains a detailed description of the individual protocols of the participatory workshops executed in the three case studies (Spain, the UK, and France). Thus, this deliverable is a collection of final protocols, tested and evaluated, that aims to provide with the necessary information to implement participatory workshops with young people, teachers, science communicators/performers and early career researchers using three different artistic approaches. Finally, Chapter 5 includes some final reflections about the implementation of the presented participatory process.

2. OBJECTIVES

The main objective of this document is **to describe the final protocol of tested methods designed to generate an interactive and transformative participatory educational process by using science and arts-based education approaches.** This collection of protocols clearly describes a series of participatory workshops that aim at assisting teachers, early career researchers, and science communicators/performers to provide secondary school students with the necessary transversal skills to generate their own PERSEIAs. In particular, the participatory workshops have been designed to promote a mutual learning scenario between scientific and educational communities that addresses RRI values and the human dimension of science through the use of performing arts, such as stand-up comedy, science busking and clown based on improvisational theatre.

To better understand the design of the PERFORM participatory educational process, as well as the role of the different actors involved, this general objective is divided into the following two operative specific objectives, which will be addressed in the subsequent chapters of this report:

1) Description of the methodology and general guidelines for the role of the stakeholders involved to set up a participatory educational process that includes a series of participatory workshops in each case study (Spain, the UK, and France).
2) Description of the individual protocols of tested methods adapted to each case study and the particular performing arts employed by the science communicators in charge: stand-up comedy by Big Van Theory (TBVT) in Spain; science busking by Science Made Simple (SMS), in the UK, and clown based on improvisational theatre by TRACES in France.

3. METHODOLOGY

3.1. Design and implementation of Participatory Workshops (PWs)

This final protocol has been designed as a result of a testing process consisting in the implementation of a set of participatory workshops in two rounds. A first round of a series of participatory workshops (PWs) was designed and implemented in five secondary schools (low and medium socioeconomic level) of three European Countries (Spain, the UK, and France) (Table 1), during the second and third school terms of 2016-2017 (from January to May 2017). On this first round, a total of 132 students, 11 teachers, and 15 early career researchers were actively involved in the PWs conducted. TBVT, SMS, and TRACES were the science communicators and performers/facilitators (hereafter, referred to as "SciCommers") responsible of delivering the PWs and organizing the collaboration of teachers and researchers in each case study (Spain, the UK, and France, respectively). The protocol designed for this first implementation included six PWs with a common structure to all three case studies, but an adapted implementation.

Case Study	School name and location
Spain	IES Santa Eulàlia, Terrassa (Low socioeconomic level)
	IES Castellbisbal, Castellbisbal (Medium socioeconomic level)
UK	Fairfield High, Bristol (Low socioeconomic level)
France	Collège Marie Curie, Paris (Low socioeconomic level)
	Collège Les Toupets, Vauréal (Medium socioeconomic level)

Table 1. Participant schools involved in the first round of PWs.

After an in-depth analysis of the development of this first round, each case study coordinator (The Big Van Theory, Science Made Simple, and TRACES), with the support of other PERFORM partners with expertise on the participatory workshops' topics (i.e. Atelier des Jours À venir, Universitat Autònoma de Barcelona, Universitat Oberta de Catalunya, and University of Bristol) redesigned their workshops according to specific needs as the educational context of each case study, the local particularities emerged during the first implementation, and the different performance approaches, in order to set individual protocols based on the specific performing arts used (stand-up comedy, science busking, and clown based on improvisational theatre). Improved workshops were then implemented and tested in each case study in a second round of PWs, from January to May 2018, in seven schools in Spain, the UK, and France (Table 2).

Case Study	School name and location
Spain	IES Consell de Cent, Barcelona (Low socioeconomic level)
	IES Moisès Broggi, Barcelona (Medium socioeconomic level)
UK	Bridge Learning Campus, Bristol (Low socioeconomic level)
	Bristol Free School, Bristol (Medium socioeconomic level)
	The Castle School, Thornbury (High socioeconomic level)
France	Collège Césaria Évora, Montreuil (Medium socioeconomic level)
	Collège-Lycée Pierre-Mendès France, Villiers-le-Bel (Low socioeconomic level)

Table 2. Participant schools involved in the second round of PWs.

On this second round, a total of 121 students, 19 teachers, and 29 ECRs were involved in the PWs. As previously, TBVT, SMS, and TRACES were the partners responsible of delivering the PWs and organizing the collaboration of teachers and ECRs in each case study (Spain, the UK, and France, respectively). This second round of PWs implementation allowed us to generate three individual protocols, each of them based on a specific artistic method, which are presented in Chapter 4.

Taken together both rounds, a total of 44 early career researchers, 253 secondary-school students (aged between 12 and 16), and 30 teachers participated in the participatory educational process that was carried out in a total of 12 selected schools (four per each case study) of Barcelona (Spain), Paris (France), and Bristol (UK), from January 2017 to May 2018. The distribution of the number of participants per country is shown in Table 3. In all cases, the schools were chosen from low and medium socio-economic contexts, as was stated in the Document of Action (DoA).

Case Study	School name and location	Students	Teachers	ECRs
Spain	IES Santa Eulàlia, Terrassa	29	3	3
	IES Castellbisbal, Castellbisbal	30	2	3
	IES Consell de Cent, Barcelona	19	3	5
	IES Moisès Broggi, Barcelona	20	2	6
UK	Fairfield High, Bristol	29	2	7
	Bridge Learning Campus, Bristol	18	3	3
	Bristol Free School, Bristol	9	2	4
	The Castle School, Thornbury	16	4	4
France	Collège Marie Curie, Paris	24	2	1
	Collège Les Toupets, Vauréal	20	2	1
	Collège Césaria Évora, Montreuil	21	2	2
	Collège-Lycée Pierre-Mendès France, Villiers-le-Bel	18	3	5
TOTAL		**253**	**30**	**44**

Table 3. Participants and participant schools distribution per case study.

The final purpose of these participatory workshops is to support students in the design, rehearse and delivering of performance-based science educational and innovative activities (PERSEIAs) to their school peers. Thus, after participating in this process, and assisted by their teachers, early career researchers, science communicators and/or performers, students are able to: (1) develop the scientific content of their performance, (2) write their scripts, and (3) stage and rehearse their PERSEIAs, in order to deliver to their peers a final PERSEIA of about one hour.

3.2. Stakeholders involved in the Participatory educational process

The methodology used in PERFORM is designed to promote a direct interaction and active participation and collaboration of all the actors involved in the development of a PERSEIA (including its audience, in this case, young people) in all stages of the process. Thus, to generate a participatory process that conducts to the delivery of a PERSEIA is necessary to involve four different stakeholders: young people (i.e. secondary school students), their teachers, early career researchers (ECRs) and science communicators and/or performers. Each of them has a specific role in the process. The implementation can be led and coordinated by the schools, outreach offices or departments of communication of research centres and universities, as well as by professionals dedicated to formal and informal education and communication of science (scicommers and/or performers).

This section includes a description of the actors involved and their roles in the three case studies carried out in Spain, the UK, and France.

3.2.1 Science communicators specialised in performing arts

Performing arts, such as stand-up comedy, science busking or clown, have the potential to offer their audiences new and unexpected ways to approach to the findings, dilemmas, puzzles, and delights of scientific research. It is not uncommon that researchers and science communicators actively collaborate, in several ways, in the development of activities that engage people in science, in which audiences can be passive or active participants. In PERFORM three professional science communication entities specialised in science and arts have led the implementation of the participatory workshops conducted.

- Stand-up comedians: Big Van Theory (TBVT) in Spain

What is stand-up comedy?

Stand-up comedy shows, designed and executed by science communicators, aim to share the enthusiasm about science through humorous performances that may take place both in places thought to hold scientific events (e.g. schools, museums, festivals) but also at places that are normally out of the scientific circuit, such as theatres, pubs, or discos. This approach has proven to be an effective way to engage people with STEM topics as part of their general culture, to inspire the next generation of scientists and engineers, and to strengthen the connection between researchers and the public.

Learn more about scientific stand-up comedy or watch a video (in Spanish) of TBVT in action.

- Science busking performers: Science Made Simple (SMS) in the UK

What is science busking?

Why wait around for an audience to turn up when you can take the show to them? Science busking is a science communication model that aims to bring the sciences to life with humour and inclusivity – by using live demonstrations- in environments where a captive audience is not guaranteed, that is, away from a science centre or museum; e.g. in the street, at festivals, on the beach, or in a crowd. Thus, people waiting for a train, networking at a conference or simply sitting in the park is a potential audience, transient, and not in attendance where 'being an audience' is the primary purpose. As such they are often the audience that researchers find themselves trying to engage with their research, both as public engagement activity and as stakeholder engagement within their research communities. As a wholly open invitation to play and investigate the world around us, busking is suitable for ages, and can be an effective means of communicating science. It is live, very interactive and can be very rewarding:

- It reinforces science knowledge
- It showcases strong science and science communication role models

- It promotes skills in science communication
- It is an enjoyable and cohesive experience
- It invites laughter

Learn more about Science Busking or watch a video of David Price and SMS in action.

- Improvisational theatre clowns: TRACES in France

What is impro and clown in science?

In the process of scientific communication, the use of the clown character induces a new look at science, and the demonstration experience in particular. From this original association between art and science emerges a freer, more naive and more impertinent link, which allows the viewer all the attitudes, from the passive contemplation to the active search for understanding, through the clarification of his relation to the science. By using the clown character and improvisation theatre (the spirit of clown is the art of improvisation), the audience and the participants can develop their creativity and imagination, in order to step into science in a different way than the way it is done or it has be done at school.

Learn more about improvisational theatre and how to use clown in science with TRACES or watch one of their videos.

3.2.2 Early Career Researchers (ECRs)

Early career researchers had a specific role in each participatory workshop. They were encouraged to actively participate in all the activities (or at least half of the sessions), providing their own experience. Their main role is to act as a 'critical friend', encouraging the students to reflect about science and scientific research, and facilitating conversations around such reflections. Thus, the presence of 1 ECR per subgroup of students is crucial to encourage the development of the process.

In PERFORM, a total of 44 ECRs (i.e. PhD students and junior post-docs) were involved in the participatory process carried out during the first and second round of implementation. Their research fields included a broad range of topics that tackle some of the EU Societal Challenges, such as "health, demographic change and wellbeing" (e.g. childhood cancer, infectious bacterial diseases (tuberculosis), antibiotic resistance, neurodegenerative diseases, antibiotics from deep-sea organisms, mitochondrial diseases, mathematics applied to population dynamics, and population health sciences research); "Food security, sustainable agriculture, marine and forestry and the Bioeconomy" (e.g. vaccines applied to aquiculture); "Smart, green and integrated transport" (e.g. rail track infrastructures); "Climate action, environment, resource efficiency and raw materials" (e.g.

ecology, sustainability and climate change); "Europe in a changing world - inclusive, innovative and reflective societies" (e.g. energy poverty and hydric vulnerability); as well as research on astronomy and cosmology, electronics, robotics, quantum computing, and plant circadian clock.

The participant early career researchers attended a training programme organised in each case study by project members of the University of Bristol, Universitat Autònoma de Barcelona, Universitat Oberta de Catalunya, The Big Van Theory and Atelier des Jours à Venir before taking part in the participatory process. To facilitate their organisation during the participatory process, they were assigned with a slot of time in which they developed specific activities related to their expertise in the context of the participatory workshops. Their participation in the final PERSEIA was voluntary. In the Spanish case study, they were asked to interact punctually with the students through *WhatsApp*, in order to solve students' questions about scientific content, or to share with the students' relevant information about ECR workday.

3.2.3 Teachers

Teachers were involved in the review of the participatory workshops activities in order to adapt them to their specific context. If possible, science communicators tried to involve science teachers as well as language and/or arts teachers into the process. Science teachers helped with the scientific content of the PERSEIAs, whereas language and/or arts teachers assisted in the construction of the story. This interaction promoted an interdisciplinary work that improved the final PERSEIA.

In PERFORM, teachers were encouraged to actively participate in all the activities during the workshops (or at least half of the sessions), to contribute to the discussions and to make sure all students are involved in the activities. Moreover, the preparation with the teachers included two meetings per school. The first of them was addressed to the school boards, and it had the objective of explaining the PERFORM project in all its dimensions. In particular, the case study coordinators in Spain, France, and the UK informed board members about the existence of the project, made them aware of the benefits from participating, encouraged the participation of the teaching staff in the project, and created synergies between the activities of the project and activities in the schools. The second meeting was addressed to the teachers directly involved in the participatory workshops. As previously, science communicators set a meeting with the teachers, in this case, two weeks before starting the participatory workshops. The aim of these meetings was to review with them the description of the activities carried out in the participatory workshops, and to receive advice on how to adapt such activities to the specific context of their school. Moreover, special attention was paid to the internal organisation of the groups. Teachers were asked to assist PERFORM members for the definition of the group of students participating in the project as well as the subgroups (small working groups) working on the sketches. Finally, teachers and early career researchers were invited to participate, together with the performers, to a "Knowledge Sharing Workshop" in each case study, which represented the starting point of the participatory process. The objective of this session was to bring the diverse perceptions about science and humanising science closer together, and ensure that all the actors understand correctly the main PERFORM objectives (Fig. 1).

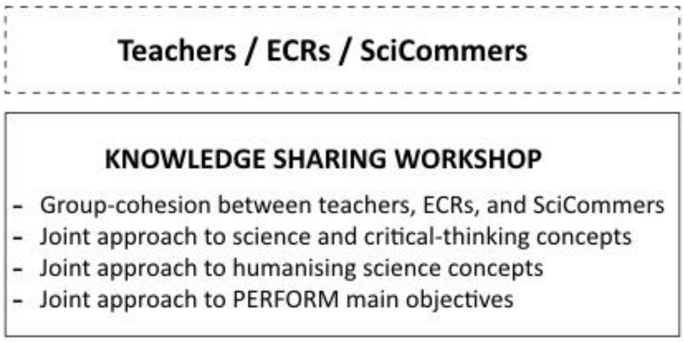

Figure 1. Objectives of the Knowledge Sharing Workshop.

3.2.4 Secondary schools students

Students are the most important stakeholders, since the aim of this participatory process is to raise scientific vocations among them as well as to provide them with skills to become authentic science communicators by generating their own PERSEIAs and motivating other youngsters to approach STEM.

Specifically, to implement this participatory process, it is advisable to work with groups of fifteen to twenty students, which may be volunteers or from the same class group. This group is divided into subgroups of students to set up small working groups composed by three or four students, resulting in five subgroups per each class group. Each subgroup works in parallel to generate a piece of PERSEIA (i.e. short monologue, busking station or impro-sketch), which is merged with the others pieces into the global PERSEIA. At the end of the participatory process, the global PERSEIA is delivered to their school peers (Fig. 2). Scicommers generally support all the subgroups of students (rotating among them and providing feedback in the rehearsals). Additionally, each subgroup works with one early career researcher or teacher. Thus, at least one of those actors helped the students.

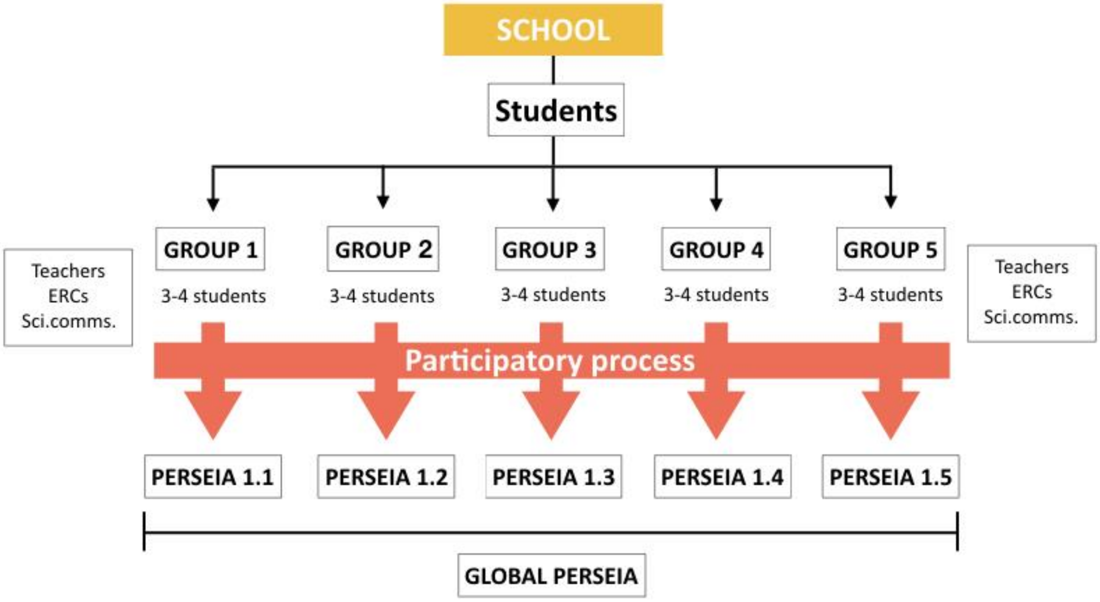

Figure 2. Distribution of the students within the Participatory Process.

3.3. Participatory Process' Organization

A series of participatory workshops of two or three hours' duration were implemented. Depending on the method used, the number and duration of each PW varied. In particular, there were conducted 7 PWs (of 2h each) in Spain, 7 PWs in France (1h30-2h), and 4 PWs (3h) in the UK. Concrete dates and time for the implementation of the PWs were stipulated jointly with the schools. The structure and duration of the PWs were adapted to the needs and nature of the performing arts used in each case study, as well as the characteristics of their local contexts. In general, the aim was to hold the PWs no more than two weeks apart, in order to give time to participants to reflect on their achievements without losing the focus on the process. Between workshops, students and ECRs were encouraged to undertake specific tasks (homework) related to the creation of the PERSEIAs.

The venue requirements to develop the PWs were the following:

- A room with tables in cabaret layout sufficient for approx. 5 groups of 3-4 pupils.
- Enough room to move from the tables to do some light physical activity. A double classroom with one end cleared of tables, or a drama studio with tables and chairs added at one end is ideal.
- A 'top table' for display of workshop materials.
- PowerPoint presentation facilities.

Additionally, different Online Interaction (OI) platforms were tested (e.g. Moodle, or private communication via mobile phone) to foster interaction between students and researchers in order to encourage students to conduct their tasks. Depending on the country, one or another (or none) of this OI was used (e.g. Whatsapp in the Spanish case study).

3.4. Ethical issues: data protection and informed consent

Any personal information collected from the persons participating (students, teachers, and early career researchers) is strictly confidential and has only been used for the objectives of this study. All the persons invited to participate in the workshops gave their informed consent. Schools gave their prior and informed consent and ethical approval of the activities to be performed. Students were asked for returning a signed parental/tutor informed consent form for participating in the project.

4. FINAL COMMON PROTOCOL OF TESTED METHODS

This final protocol of tested methods is based on three artistic approaches: stand-up comedy, science busking, and clown based on improvisation theatre. Each of them has specific characteristics and conducts to a different kind of PERSEIA, i.e. scientific monologues, busking stations, and a series of impro-sketches, respectively. Taking into account their features and requirements, local context of implementation, students and teachers' interests, as well as time constraints, users of this protocol can follow one or another to generate the PERSEIAs. It is also possible to combine some of the activities described in order to adapt them to the stakeholders' interests and needs.

In particular, stand-up comedy conducts to the construction of scientific monologues that requires writing scripts, thus, combines artistic and linguistic skills. On the other hand, science busking involves manual activities, since it is based on scientific experiments, which makes it more attractive for youngest audiences. Finally, clown/impro theatre is more unstructured as it is based on improvisational sketches, which helps to buster creativity.

A key point of the participatory process described in the following collection of protocols is that it allows us to introduce the human dimension of science and the values embedded in the Responsible Research and Innovation (RRI) approach. The designed participatory workshops integrate values such as the inclusiveness of all participants (in order to balance participation and foster dialogue among participants), the integration of ethical issues by connecting science and values (e.g. critical thinking about scientific research), or the inclusion of gender perspective and critical approach of gender issues in research (which has been worked transversally during the process, as well as in specific activities).

4.1. Stand-up comedy by The Big Van Theory (TBVT) in Spain

Main goal of this approach:

To construct a scientific monologue is a way to boost the interest of secondary school students on science through an artistic approach where the scientists are not "the experts" any more. With the assistance of teachers and science communicators, a true dialogue between all the different actors participating in the process raises, generating a safe space where the human dimension of science is shown to the students by scientists (the early career researchers) while they together and collaboratively creates a scientific stand-up comedy show.

Specific Objectives:

- To engage students and their teachers in science related to researchers' work.
- To support early career researchers in the interpretation of their research for the school - and ultimately public – audience.
- To encourage active participation of students in the monologue creation.
- To ensure researchers' expertise is fully used throughout processes with students.
- To encourage active participation from teachers.

Methodology:

Seven workshops are held in secondary schools, each of 2 hours' duration (Figure 3). The workshops drive early career researchers (ECRs), students and teachers through a participatory process in order to develop a science monologue, which engage audiences in the topics of the ECRs' research. The monologue is developed through a collaborative process between researchers and students and topics are chosen and subject matter included through a process led by the interests and motivations of students.

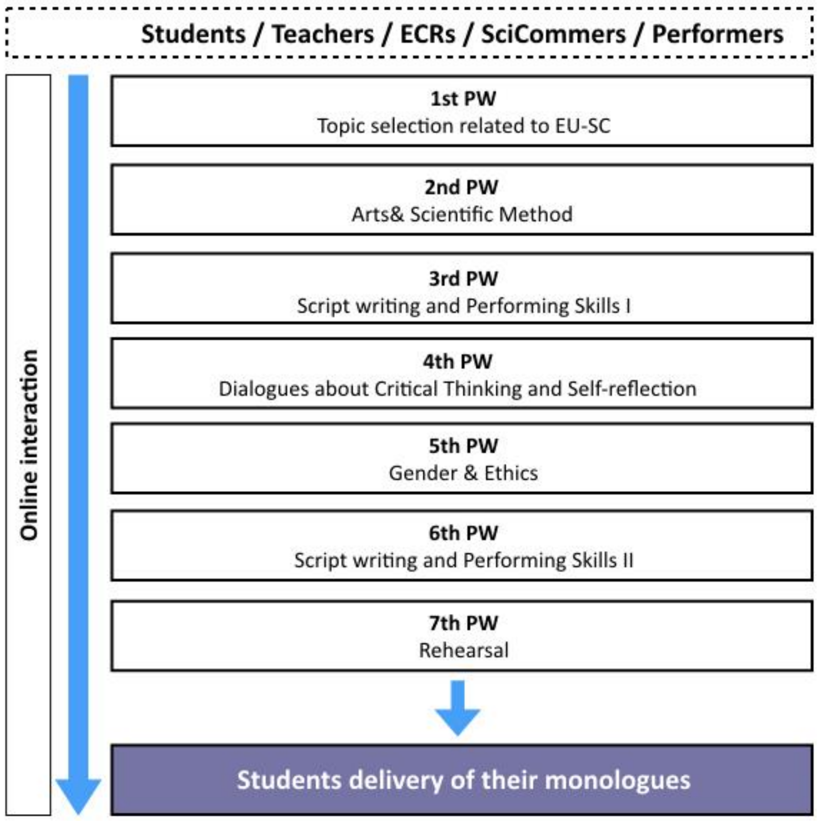

Figure 3. Series of Participatory Workshops (PWs) as implemented in Spain.

Venue requirements and material:

- A classroom with tables in cabaret layout sufficient for approx. 5 groups of three or four, sufficient for students to work in groups with an ECR.
- Enough room to remove the tables to do some light physical activity. A double classroom with one end cleared of tables, or a drama studio with tables and chairs added at one end is ideal.
- PowerPoint presentation facilities.

Some considerations before starting:

- The ideal size of the group of students is between 10 and 15. Therefore, if there are more students in the class, it should be split into 2 groups.
- Teachers are encouraged to work with the students between two participatory workshops, in order to refresh the students' knowledge.
- Together with facilitators and teachers, Early Career Researchers (ECRs) should follow a brief training, in order to learn how to popularize their scientific work and to best prepare their interventions during the workshops.

PARTICIPATORY WORKSHOP 1: REFLECT ON SOCIETAL CHALLENGES AND SELECTION OF THE SCIENTIFIC TOPIC

Goals: To assist students to understand the PERFORM participatory process, and to start thinking about the scientific topic they want to talk about in their monologues, relating it to some of the EU Societal Challenges as well as the research field of one of the ECRs involved in the participatory process.

Specific objectives:

- To facilitate students to understand the aim and methodology used in the project, and the role of all people involved (SciCommer/s, ECRs, and teacher/s).
- To make clear to students that they will produce a PERSEIA at the end of the participatory process.
- To make students aware of some current societal challenges, such as sustainable food systems, health and wellbeing, or clean and efficient energy systems, and the role of science and scientists.
- To make students aware of the relationship between different scientific areas, the EU societal challenges, and STEM jobs.

- To break stereotypes about scientists (humanisation of the researchers) by showing how researchers look like, describing their academic background since secondary school, and illustrating the variety of research fields they represent.
- To bring the ECRs' research topics closer to the students in order to facilitate that they choose for their monologues topics related to what the researcher has studied or what s/he is investigating.
- To establish the specific working groups (SWGs).

Students' skills and competences worked:

Sense of initiative: students choose the scientific topic they want to convert into a monologue.

Social and civic competences: the selection of the topic involves group discussion, and the collective and participatory interaction with ECRs, teachers, and Science communicator/s, both face-to-face during the PWs, but also through online interaction (via *Whatsapp*).

Learning to learn: students interrogate themselves about what they know about a given scientific topic and what motivates them to learn more, basic cognitive aspects of the scientific topic.

Description of the activities:

Material Needed: MAGIC Cards (see Annex 1), Post-it.

Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room and the number of students participating in the workshop.

1. Introduction to the PERFORM project actors (10')

Science communicators (SciCommer/s) introduce themselves briefly and explain their role in the project as a trainers/facilitators of the workshops.

ECRs introduce themselves briefly and explain their role in the project.

2. Warming Activities (15')

Play two or three warm-up activities. Select simple games or activities that involve movement and that encourage the interaction between the different stakeholders (pupils, teachers, ECRs and facilitators); all of them should participate in the warm-up.

2.1. *Write your name (3'):*

Pupils, ECRs, teacher/s and SciCommer/s, stand in a circle and write their full name in the air with their right index finger, then left index finger, then right big toe, then left big toe and then with their bottom.

2.2. *Stage me (3'):*

All students are placed in a circle, facing outward. Trainers say a profession or feeling and everyone turns quickly and stays frozen in a posture that dramatizes what was said. Examples: laboratory mice, monologist, DNA, laugh, geology, etc.

2.3. *The pirate ship (3'):*

Pupils, ECRs, and teachers walk around the classroom. Trainers –acting as the captains of a ship - give orders to their sailors. The last person to execute the order throws itself at the sharks, while shouting her/his last wish. The orders are: (1) Go to starboard!: everyone stands in a line on the right side of the classroom, holding the shoulders of the person in front on her/him; (2) Go to port side!: everyone stands in a line on the left side of the classroom, holding the shoulders of the person in front on her/him; (3) To row!: everyone sits in the centre of the room, making a line, placing themselves between the leg of the person behind, and doing the rowing action; (4) Clean the deck!: everyone crouches down to wipe the deck; (5) Land in sight!: everyone makes a line in the centre of the classroom, looking at the distance; one hand making a visor, and the other one pointing to the horizon.

Figure 4. Example of warm-up activity in which students, teachers, ECRs and SciCommers are involved. School Moisès Broggi, Barcelona, Spain.

3. Participatory Activity: General introduction to the PERFORM project (15')

The main objective is to guide students to understand the objectives of the PERFORM project and their participation. It is important to highlight that students will present a SCIENTIFIC MONOLOGUE SHOW (their PERSEIA) at the end of the participatory process. First, the science communicator briefly explains the artistic discipline that will be used (i.e. stand-up comedy) and how it is used to disseminate scientific concepts. Then, the communicator asks students "How do we create a Scientific Monologue Show?" and "What elements do we need"? in order to guide a discussion on the necessary elements and steps (e.g. topic, story, script, performance, etc.). Finally, the SciCommer/s write on the whiteboard the arisen ideas that are linked with the PWs:

- Selection of the scientific topic
- Creation of a story that catches the public

- Definition of the scientific content to transmit
- Script writing
- Performance

4. Participatory Activity: Scientific issues related to the EU-Societal Challenges (cards game) centred on the participant ECRs (50')

SciCommer/s ask students what a societal challenge is, which societal challenges have humanity, and how science may tackle them. The given answers are written down on the whiteboard. Following, each ECR briefly explains (3-5min) to the students their academic career (from secondary school to postgraduate studies), highlighting the knowledge acquired, as well as personal motivations, interests and/or difficulties, in order to humanise the scientific career. Then, they detail the main knowledge that s/he has acquired, her/his current Ph.D. research, and the EU-SC that s/he addresses. The ECRs have to prepare in advance their speeches, as well as to provide a picture of their projects and the EU-SC they are tackling.

Next, the SciCommer/s explain the game, showing students the EU-SC cards they are going to use: in small groups (3-4 students), students generate a Scientific Project that an ECR may conduct in order to solve a specific Societal Challenge. First, students choose one "Project Card" (these cards address the eight EU-SC as well as specific projects associated to each ECR). Next, they select the "Scientific Cards" based on the type of scientist that may be more suitable to address its EU-SC (these cards show a photo of a scientist and brief description of their capabilities, e.g. a scientist using a micropipette; person able to understand how genes work and modify the genome of cells and/or animals). They may include as many cards as they consider relevant to solve the chosen project. Finally, they pick the "Place Cards" (these cards show a workspace with a brief description of what is done there, e.g. molecular biology lab; place where experiments to modify genes and to study the effects of drugs in cells and/or animals are made).

During the activity, teachers and ECRs help students to understand the concepts, by explaining and resolving the doubts that arise. SciCommer/s keep students focused on the activity and are responsible for maintaining order, preventing too much noise or out-of-control situations.

At the end of the activity, each group of students explain to the entire group (situating themselves in front of their audience) their ideas to address EU-SC using the cards they have chosen.

Figure 5. Students presenting the scientific project generated through the cards game. School Moisès Broggi, Barcelona, Spain.

5. Reflection on the choice of monologue topic (20')

Students are asked to think about a topic they would like to talk about in their monologue. The SciCommer/s, teacher/s, and ECRs help students to reflect on the following key points before choosing the topic:

- To think about a topic that you like and / or that motivates yourself
- To think about a topic that your audience may like and / or that motivates them
- To think about a topic from which you CAN LEARN and SEEK OUT information

At this point, the SciCommer/s suggest connecting scientific topics to the research topic or the field of study of the participant ECRs, which may help students in the construction of their monologues. In this way, ensuring that the topic is connected to ECRs greatly benefits the process as it fosters the integration of ECRs, their exchange with students and, in turn, the learning and engagement of students. Moreover, the SciCommer/s may ask students to relate their topics to any of the social challenges previously presented. Each student writes in a post-it the topic that s/he would prefer and her/his name, and sticks it to a whiteboard/blackboard. Finally, students are asked to reflect on the methodology they will follow to build up the monologues. The session ends here.

6. Homework for SciCommer/s: Generation of the SWGs (10')

SciCommer/s review the post-its and generate the SWG by putting together students with similar topics and scientific interests. At this point, it is possible that the SWGs are not definitive. During the PW2, students will have the chance to modify their choice. Once defined the topic, the SWGs are maintained during all the process. Each SWG have to agree on a common scientific topic, and to share a common PERFORM notebook in which they write the script of their PERSEIAs. SciCommer/s try to guide the topic selection to the research field/topic of the ECRs involved in the process.

PARTICIPATORY WORKSHOP 2: ARTS & SCIENTIFIC METHOD

Goal: To reflect on the methodology followed in the process of construction of scientific knowledge and artistic productions to apply it to their monologues.

Specific objectives:

- To identify the connections between scientific research and artistic practice.
- To define the content of the monologues considering scientific and artistic perspectives.

Students' skills and competences worked:

Social and civic competences: group discussions encourage collective creation, cooperation within the group, negotiation of content, and discussion skills.

Creative and critical thinking: identification of relevant scientific content and critical questions, and translation into a stand-up monologue.

Description of the activities:

Material Needed: party balloons, and notebooks

Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room.

1. Warming Activities (15')

All stakeholders involved participate in the warming activities.

1.1. Walking around (3'):

Students move around the classroom, without making circles, randomly. The trainers give instructions to move parts of the body, starting with the fingers, shoulders, arms, and, eventually, moving all parts of the body at once.

1.2. The balloons (6'):

Ask each student to inflate a party balloon, to put it on a chair and to sit on it without explode it. Ask them to explain why some balloons do not explode. This activity links humour and science (physics), which is a good vehicle to show student how to use props (e.g. balloons) to disseminate science in a way that they may want to take home and try by themselves or with others.

1.3. The chairs (6'):

Each student takes a chair, puts it somewhere in the classroom and sits on it. They cannot speak to each other. When the facilitator claps her/his hands, each one of the students has to exchange her/his seat with another one very quickly. The first time, it may be a mess.

Then, the facilitators make them think how to do it better, and make them start thinking as a group. At the beginning, when we say they have to exchange "quickly" they think it means they have to do it as fast as possible individually. Do not mix speed and haste. Ask them to make eye contact with partners to be sure they are going to exchange with them. This activity allows them to learn how reaching agreements may benefit the group: if they choose a seat that is close to them, but it is already promised to someone else, ask them to find another one that is a little further. The individual objective might not be accomplished, but the result may be more advantageous for the group.

2. Review of the ECRS's research fields/topics (10')

Researchers explain again (briefly) their research topic to the students as they have learned in the PERFORM training. According to the information of the post-its (see PW1 section 6), the students are divided into SGWs based on the similarity of the topics. If needed, SciCommer/s may assist students to focus their topics to the research field/topic of the ECRs involved in the process, which facilitate the interaction among the participants. These working groups carry out the following exercises.

3. Participatory Activities: Arts & Scientific methods activities (55')

3.1. Methods in the arts and science I (20')

Start with a brief reflection on the methodology followed by scientists. Ask the students if scientists follow a specific methodology in the production of knowledge. Help them (if needed) to enumerate the 5 steps of the scientific method (Observation; Hypothesis; Experimentation; Results; Conclusions), and write them down in the blackboard. Then, ask them if artists also follow a specific methodology in the production of artistic works. Initiate a brief discussion about the commonalities of both approaches.

Each ECR explains how s/he applies the scientific method in his/her research. This is a good opportunity for students to see different approaches to scientific methods and open their minds.

Next, based on the information provided by the students in the previous session (post-its), about the topic they would like to present in their monologues, the trainers split up the GWG into SWG according to their interests. Each SWG is (ideally) associated with one of the ECR involved in the process.

3.2. Methods in the arts and science II (35')

Previously, each ECR has provided an image that represents her/his research field/topic. This image is given to the SWG in which the ECR is assisting the students. One of the groups gets the image of an artistic work (e.g. a sculpture, an opera, a famous picture, etc.)

and the others the scientific images (See Annex 2). Explain that the image they have is the result of an artistic/scientific work and ask them to perform 5 moments of the 5 steps that the artists/scientists carried out to achieve that result (they should remain frozen, using their bodies as if they were photos). They have 10 min to prepare the moments they will represent in front of the other SWGs. ECRs, SciCom and teachers join the groups to answer questions and keep the conversation focused on the subject. It is not necessary that all group members participate in the performance. The task can be distributed and each image can be done by 2 or 3 students (or as many as necessary). The other students must interpret and say what they observe. Moreover, assisted by the SciCommer/s, the ECRs can also perform the scientific method applied to in her/his own research using "frozen moments".

Next, open a discussion about the global processes and methods followed in both, arts and science, taking into account the concepts below:

> *The scientific method outlines a basic plan for scientists to follow when answering a question: define the problem; form a hypothesis; experiment and make observations; analyse data and make conclusions; and publish, receive feedback, and revise as needed[1].*
>
> *The artist hypothesizes through his or her initial creation, experimenting with the chosen medium and gathering research to enhance understanding of the issues or questions approached. Once the artist has completed the initial creation, he or she will revise, rehearse, and make adjustments as necessary.*

Discuss with the students if this methodology can solve problems and reach solutions in a reasoned and tested way:

> *An individual does not have to be a scientist to use the scientific method. [...] Individuals ask and answer questions, using the scientific method for common everyday problems.*
>
> *Also, creative processes like those happening through the arts can help us grasp new knowledge and understanding in different but complementary ways to the knowledge generated through scientific approaches. Through the creative process of the PERSEIA (e.g. improvisation, narrative, exploration with objects) we are also doing research.*

4. Definition of the scientific content of the monologue (40')

Organise the students in the assigned SWG (based on their preferences), and give them the

[1] Broaddus, A. (2013). The Scientific Method and the Creative Process. Berkeley Planning Journal, 26(1), 217–220. http://doi.org/10.5811/westjem.2011.5.6700

post-it they wrote at the end of the previous PW. Moreover, each working group receives a notebook, in which they will write down everything related to their monologue. Each working group must decide, from the (similar) topics that they wrote in the post-its, the one that appeals to all the members of the group. As in the previous PW, students are asked to consider the following aspects when deciding about the topic of their monologues:

- To think about a topic that you like and / or that motivate yourself
- To think about a topic that your audience may like and / or that motivate them
- To think about a topic from which you CAN LEARN and SEEK OUT information – At this point, it would be relevant to remark that may be easier for them to connect the topic of their monologues to the research field/topics of the ECRs involved.
- To consider a topic that addresses any of the social challenges discussed in the previous PW.

Teacher/s, ECRs and SciCommer/s supervise the work done by each SWG to encourage constructive discussion among the students and to ensure that the choice of the subject is made based on the above features. In particular, ECRs act as a "critical friend", motivating students to choose a topic that may be related to her/his field of study.

Each SWG, assisted by teacher/s, ECRs and SciCommer/s, sets 3 to 5 ideas about the scientific topic selected, related to their own interests. These ideas may be formulated as questions, even as hypotheses, but also as simple sentences. The objective is that students define "what I want to tell in my monologue".

Once students have chosen the topic, they must put into practice the scientific steps they have identified during this workshop. They must define the first steps of their monologue: observation and hypothesis. That is, each group should define, based on their topic, what might be of interest for their audience and how it could be related to the social challenges discussed in the previous workshop.

Finally, students write down in their notebook the final ideas arisen related to their monologues. The notebook is collected and kept by the communicator until the next workshop.

PARTICIPATORY WORKSHOP 3: SCRIPT WRITING AND PERFORMING SKILLS I

Goal: To construct the general structure of the monologues.

Specific objectives:

- To identify the general structure of a scientific monologue.

- To (critically) define the main scientific ideas that they are going to include in the monologues.
- To initiate the construction of an attractive leading story in which include the scientific content.
- To practice the necessary performing skills to speak in public.

Students' skills and competences worked:

Learning to learn: ability to pursue and persist in learning, effective organisation (i.e. time and information management).
Social and civic competences: communication skills, collaborative skills, informed and reasoned decision-making, ability to resolve conflicts.
Sense of initiative and entrepreneurship: ability to turn ideas into action, self-confidence and esteem, ability to plan and manage projects.

Description of the activities:

Material Needed: party balloons, and notebooks
Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room.

1. Warming Activities (15')

All stakeholders involved participate in the warming activities.

1.1. *Rubber chicken game warm up (5')*

Pupils, ECR's, teachers, and trainers stand in a circle and count down from 5 to 1, while shaking each limb, 5 times, then 4 times, then 3 times, etc. When 1 is reached everybody leaps into the air and cries out "rubber chicken" as loud as they can.

1.2. *Walking around (5')*

We return to the previous exercise of walking around the classroom adding the following instructions: when the SciCommer/s shout a number from 1 to 5, the participants must answer by shouting the following words with plenty of gesticulation. They must not only shout the word, but to interpret what it means (some examples):

- Taxi (gesture of calling a Taxi)
- A person's name (s/he the beloved person, call her/his with a lot of love)
- Crap! (Something went very wrong)
- Eureka! (You have discovered something wonderful)
- Puahg! (Something is really disgusting)

1.3. *Use of the voice (5')*

Students, teachers and researchers walk randomly around the classroom. The communicator claps one, and they organise themselves in pairs to explain to each other what they had for dinner last night. The SciCommer/s clap again and say in which language the conversation should be from now on. The languages may be: Catalan (or Spanish), Chinese Mandarin, Russian, Arabic, Italian, and an invented language. When finished, it is explained to the students that using the tone of voice, they are able to communicate. This activity highlights the importance of using different intonations to facilitate the communication by relating the tone of voice with the message transmitted.

2. Generation of the monologue structure (40')

Organise students in SWGs. If there are several ECRs (desirable!), each of them follows 1 or 2 specific working groups, in particular, those that are closer to their field of study or research. This may contribute to generate a close relationship with the students.

Each SWG defines 3 to 5 implications that their chosen topic has with their everyday life or with their interests. This exercise helps them to explore and define "what I want to tell in my monologue". Once the implications have been defined, they should convert them into "research questions". Thus, by answering those questions, they are defining the content of their monologues. It is not necessary that they answer those questions in this session, only formulate them.

ECRs, teacher/s and SciCommer/s visit the groups and help students to construct their research questions, by acting as "critical friends". In particular, researchers have the role of guiding/redirecting some of the questions to their field of study/research.

Next, the SWGs are put in pairs in order to share and discuss the implications and questions found. Once listened to each other, they should provide feedback to their classmates. Some of the topics to discuss may be the following:

- What specifically interests me about this topic? Could the theme chosen be exposed in a more interesting way?
- Do the research questions refer to issues that really interest me? Could I address those questions in a more interesting way?
- Do the research questions make me think about science? Do those questions inspire me to want to know more about that topic?

If there is enough time, the exercise of counting and giving "feed-back" is repeated.

Finally, each working group writes in its notebook the implications and research questions that they have finally decided to address.

Figure 6. Students and ECRs working together on their research questions. School Consell de Cent, Barcelona, Spain.

3. Performing skills I (20')

Chairs are relocated as in a theatre, leaving some space for the "stage". Each SWG explains in front of their classmates the research questions formulated in the previous exercise. The SciCommer/s provide feedback about the oral presentation made by the students: e.g. scenic position, use of the voice, and making eye contact with the public. Additionally, ECRs and teachers give feedback on the formulation of the research questions. The students must take notes of the feedback in their notebooks.

4. Definition of the narrative situation (30')

It is explained to the students that their monologues must have a story. Use this example to analyse the narrative situation. After watching the example, ask the students to think about the narrative situation of their own monologues, and to write in their notebook its structure. ECRs visit the SWGs and act as "critical friends" by trying to encourage students to reflect on the scientific content of their monologues. ECRs may guide students to include or relate the topics to their study and/or research topic. Each SWG work in its monologue for 20 minutes. Students write on the PERFORM notebooks the ideas generated.

5. Performing skills II (20')

5.1. *Body language*

Students, teacher/s and ECRs make a circle. The SciCommer/s say a sentence. One of the students goes to the centre of the circle and represents, only using mime and in a very subtle way, the phrase said looking at one of other students. The student who has received the phrase comes out in the middle, s/he addresses to another student, and represents the same sentence again, but exaggerating more the movements and gestures. Repeat this dynamic, increasing the exaggeration each time, including also the voice until finishing in a scream. Some proposed phrases are the following: Your armpit smells/You owe me money/I want to be your friend.

5.2. Stage the narrative situation

Each working group prepares themselves to stage their narrative situation, which is presented in front of their classmates, teachers and researchers. In these exercise, students only use mime to perform, while the audience should guess what narrative situation they are representing.

At the end of the exercise, it is explained to the students that also using body language messages can be transmitted to an audience. Thus, both oral communication and body language are essential when representing a monologue.

PARTICIPATORY WORKSHOP 4: CRITICAL THINKING AND SELF-REFLECTION

Goal: To provide students with notions about the importance of critical thinking and self-reflection in science, which will help them to define the scientific concepts of their monologues.

Specific objectives:

- To show students that scientific research is a social practice rooted in our culture and history.
- To understand some of the criteria to consider the reliability of a source.
- To show student how (and where) to find reliable information about scientific research.

Students' skills and competences worked:

Learning to learn: criteria of reliability and reflective thinking.

Social and civic competences: critical and creative thinking, sense of collaboration in the construction of science, communication skills, informed and reasoned decision-making.

Description of the activities:

Material: Stations, Questions for each station, tips for improving critical thinking (See Annex 3, in Spanish).

Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room.

NOTE: SciCommer/s and researchers prepare in advance, at least, one of the stations to relate it, specifically, to the research conducted by the early career researchers.

1. Warming Activities (10')

All stakeholders involved participate in the warming activities.

1.1. *Radiation game* (5')

Pupils, researchers, teacher/s and SciCommer/s stand in a circle in a large uncluttered space and each (anonymously) number the members of the group with "1" or "2". SciCommer/s explain that "1" is a highly dangerous radioactive source and "2" is a protective lead shield. The aim of each person in the group is to place a lead shield between themselves and the radioactive sources.

1.2. *Active listening* (5')

Trainers ask for 5 volunteers (students) to stand in front of the entire group (including teachers, and researchers). They are placed in a row, side by side. The communicator says a number from 0 to 5 and they must quickly crouch down the number of volunteers the communicator has said. They cannot talk to each other to organize themselves. The exercise can be repeated with other volunteers. The aim of this exercise is to practice an active listening. At the end of the activity, it is explained to the students that they have to listen to other actors (i.e. their classmates but also the public), in order to quickly adapt the representation to unexpected situations.

Figure 7. Example of warm-up activity. School Moisès Broggi, Barcelona, Spain.

2. Participatory Activity: Scientific News for Critical Thinking (70')

Prepare four tables to be laid out around the classroom; each of them represents one 'station' that displays headlines about scientific findings or scientific information published in newspapers, scientific journals, or websites. Each station is aimed at promoting the discussion about, for instance, sources of information, reproducibility of scientific research, or conflict of interests (See Annex 3). In order to ensure the discussion, each station includes a list of "Questions" that are used as a guide to generate the discussion. Previously, early career researchers have been asked to review the 4 stations and to propose a piece of news related to their field of research that may be included in the activity. In this case, the researchers are in charge of that station acting as a facilitator. Moreover, if possible, try to adapt the different stations to the topics and fields of research of the researchers; if not possible, the stations in the annex can be used.

Students are split up in the SWGs and work their way round the different stations. In each station, students are invited to read the newspaper headlines and decide whether they should trust the claim made or not, and why. In each station one adult (teacher, SciCommer or researcher) is in charge of guiding students through the "Station Questions", and to maintain them focused on the discussion.

If there are more groups than stations, some stations will be replicated.

Each SWG is provided with a worksheet (See Annex 3) that assists them to record their responses and reflexions of each station. If necessary, one adult (teacher, researcher, or SciCommer) may assist the students with some clues in order to promote the discussion between the students. For example, in Station 1 the info may not be trustworthy because there may be a conflict of interest with the research funders.

Students spend 10 minutes on each station (30-40 min in total), discussing as a group and taking notes individually. Then, facilitators spend 30 minutes discussing with the whole group, their findings and comments related to the questions addressed in each station.

Brief summary of the stations:
Station 1: Information sources. Who makes the scientific statement? *The station shows two different sources of information that present the relationship between guanabana and cancer: one comes from an online magazine, and the other one from a journal article written by a recognizable research group.*
Station 2: Conflict of interests. Is there any conflict in who makes the scientific statement? *The station shows a research funded by Coca-Cola in which the company claims that sugar is not harmful to health.*

Station 3: Scientific evidence. What are the evidences that validate the scientific statement? Are the conclusions drawn valid? *The station shows two different claims on the effect of black pepper on slimming diets. Both sources cite the same study, but in the first example, the research is not contextualized, while in the second one, the authors provide more information regarding the methodology followed in the study (single study in mice).*
Station 4: Dissemination of scientific information. Can errors occur in the dissemination of scientific information? *The station shows two different headlines: one from a generalist media, and the other from the original journal article in which the news is based on. According to the findings of the researchers (read the abstract), the effect of chocolate is ephemeral; by contrast, the media headline is more categorical.*

Figure 8. Students, teacher/s, early career researchers and SciCommer/s working together in the stations' questions. School Consell de Cent, Barcelona, Spain.

Once the students have visited each station, the facilitators promote a whole group discussion. Addressing each station, ask students to give reason to trust or not the exposed claims, and why. There should be room for disagreement in this discussion, for example, one researcher giving evidence that conflicts with a body of established research does not necessarily mean that they are wrong, just that we might need further evidence before committing to belief in it. Direct the discussion to some of the following topics to address some of the criteria that give reliability to a scientific piece of news, for example:

- Science is constructed by a community. Scientific information/claims should contain references to other peer-reviewed articles. Explain here to students what means "peer-reviewed journals" and "reproducible data" (Station 1)
- Some scientific studies may be manipulated due to conflicts of interests. In this case, does the one who gain reputation with the study (Coca-Cola) is the same person or institution that provide the funding for the study? (Station 2)

- In press releases, the information may not be accurately described. Always read to the original source or related press releases (Station 4)

Ask students whether they can think of any other criteria that might be important to consider whether a source of information is trustworthy or not. Next, ask students what our response should be if a source fails on one of the criteria (e.g. Coca-Cola funded research on the harmless effects of sugar) – should we no longer trust the research? Does it mean that the research is definitely wrong? Finally, ask the students if a source passes every item on the checklist, should we believe it? (There is no correct answer to this – we just want the students to think about where the boundaries of certainty are in relation to scientific evidence).

Figure 9. Open discussion of the issues worked in the different stations. School Consell de Cent, Barcelona, Spain.

3. Critical capacity for information searching (35')

Give the students the document that includes some tips for improving critical thinking (see Annex 3). By using a projector, the researchers or SciCommer/s conduct an Internet search of information related to their own research topic, and following a critical approximation to some "not trustable" or "not scientifically" information that can appear in the Internet. Volunteer students drive other searches related to their own scientific topics. Students are encouraged to repeat the search at home. Not as homework, but as a recommendation.

PARTICIPATORY WORKSHOP 5: GENDER AND STEREOTYPES

Goal: To develop students' creative capacity to generate stories that include scientific content as well as gender issues and stereotypes associated with STEM careers.

Specific objectives:

- To visualize social gender stereotypes affecting, in particular, girls' decision to start STEM studies - Detecting and reflecting on toxic cultural messages.
- To generate and stage sketches that include gender issues and negative stereotypes in science in order to foster positive messages.

Students' skills and competences worked:

Sense of initiative: entrepreneurship, self-confidence and esteem.
Learning to learn: reflective and critical thinking.
Social and civic competences: communication skills, collaborative skills, informed and reasoned decision-making, ability to resolve conflicts.

Description of the activities:

Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room.

NOTE: *Without explaining it to the students, it should be taken into account that the main objective of this workshop is to work on stereotypes and cultural pressures of GENDER. But this should not be explained to the students, since it usually provokes rejection by the male gender. We have to guide the workshop by saying that we are going to talk about cultural stereotypes and pressures that influence students not to choose STEM careers.*

1. Warming Activities (15')

All stakeholders involved participate in the warming activities.

1.1. *Different kinds of bodies* (10')

The students walk in the room, randomly. They can interact with chairs, tables and objects if they want. But they cannot stay seated more than 5 seconds.
The facilitator tells them (some of the) 12 different adjectives, they are going to try to modify their body, and they way of moving, in order to fit these adjectives, and even exaggerate it. By doing so, the facilitator asks them to see if they feel differently, and try to speak, to see if they speak the same way than when they act normally.
The 12 adjectives are distributed in 6 couples of contraries:

- Fast / slow
- Soft / rigid
- Rhythmic / non-rhythmic
- Open / closed
- Aerial / earthy

- Direct / non direct (when they do an action)

By using 2 or 3 adjectives at one time, they can generate a character very quickly.

Figure 10. Example of warm-up activity. School Consell de Cent, Barcelona, Spain.

1.2. *Exaggeration as a way for scenic creation* (5')

Pupils, teacher/s, researchers, and SciCommer/s form a circle. One person transmits a feeling/message to another. The one who receives the feeling is the one who transmits it to another person in the circle, and so on. At each transmission, the intensity in the transmission of feeling increases. The activity starts by using mime, and it ends with the use of the whole body and voice. The feelings/messages may be, for instance, "I want to be your friend" or " you owe me money".

2. Participatory Activity: Gender stereotypes in science (60')

Split students in groups of four: 2 boys and 2 girls. Each group receives some instructions about a short sketch that they have to stage. They have some time (15') to build up the sketches. They have to construct and play the role of one of the characters. Researchers, teachers and SciCommer/s visit the groups to get students focused on the activity. Sketches and instructions proposed are the following, although they can be also adapted to the topics being approached by students in their PERSEIA.

A. WIRELESS INVENTION

To stage the situation where Wireless technology (Wi-Fi) was discovered. Characters:

- An engineer expert on torpedoes
- An URSS spy
- An hotel receptionist
- A Nurse

B. MOP INVENTION

To stage the situation where mop was invented. Characters:

- An aeronautic engineer
- A domestic worker (menial)
- A very dirty cook
- A scrupulous cleanliness person

C. *TO FIRE A WORKER IN A TECH COMPANY*

To stage the situation where the CEO of a Tech Company needs to fire 2 workers due to the last economic losses. Characters:

- The CEO of the company
- The Secretary of the CEO
- A labour-union representative
- An assembly line-worker

D. *EUREKA, I DISCOVERED IT*

To stage the situation in which a scientist just discovered the HIV-Vaccine and runs to home to explain to the family. Characters:

- A scientist
- The scientist couple, dedicated to menial housework
- A couple descendant
- The descendant tutor

E. *JOB INTERVIEW*

To stage a job interview in which a tech company requires an expert in mathematics.

Characters:

- Two interviewers
- Two job applicants

Figure 11. Students, teacher/s, early career researchers, and SciCommers working together in the preparation of the sketches. School Consell de Cent, Barcelona, Spain.

Students deliver their sketches to the entire group. Once represented, a global discussion is opened with all the students. SciCommer/s, teacher/s and researchers drive the discussion, pointing out at least these topics:

WIRELESS / MOP INVENTION

Analyse who plays each character related to gender. Explain that STEM careers and Jobs are not gendered bias per se. Here, the researcher gives data about actual state of things (e.g. about men / women ratio in science in positions of responsibility) and also can share his/her particular vision about that.

TO FIRE A WORKER IN A TECH COMPANY

Analyse who plays each character related to gender. Management skills are well seen in men, but not in women: e.g. boss/bossy, persuasive/pushy, dedicate/selfish, neat/vain, smooth/show-off (watch this video). Try to highlight how boys show themselves more self-confident as the important skills for management are associated to male gender, while girls do not associate management skills with their abilities.

EUREKA, I DISCOVERED IT

Analyse who plays each character related to gender. For boys to have children is not a problem, it does not affect their compromise with the jobs, but for girls it is. And there is an enormous social pressure to be mother and to stay at home taking care of children.

JOB INTERVIEW

Analyse who plays each character related to gender. Usually, girls show feelings of lacking self-confidence and being extremely perfectionist. As job-applicants, girls show themselves less prepared than boys.

Figure 12. Students performing their sketches in front of the entire group. School Consell de Cent, Barcelona, Spain.

General discussion/conclusion: Introduce the idea that using theatre (performing arts) allows us to call attention to social stereotypes, and to break them down.

3. Participatory Activity: Development of students' PERSEIAs (45')

Divide students into the SWGs. Each working group prepare a short sketch in which they represent the narrative situation chosen in their monologue (see PW3). The aim is to modify, if needed, the narrative situation to avoid perpetuating stereotypes and even to break them. To do so, we carry out an exercise of improvisation to generate content that may be useful for the monologues, by outlining the following aspects:

- Situation in which the scene takes place
- Characters who participate in the scene
- Scientific content to be included (related to their monologue)
- Possible stereotypes to break out and/or positive stereotypes to highlight

Once defined, students prepare their sketches. If the SWGs have chosen any of the research topics of the participant researchers, they can help the students in the creation of the scene, even they can participate in the performance if wanted/needed. Teacher/s and SciCommer/s visit the different SWGs to assist students in the construction of the scene. Finally, students perform their sketches in front of the entire group. Be creative to do it. Some possibilities are the following:

- Just to name a few stereotypes during the monologue.
- Name the stereotypes through talk about scientists that have been affected by it (Ex. Alan Turing, Sophie Germanie, Emmy Noether…).
- Name the stereotype and show effective ways to overcome it.
- Students can find their own way in order to talk about that in their PERSEIAS.

Encourage critical engagement with gendered issues (in light of what they have just learned) that may have come to light in their monologue, however do not feel the need to force the issue – gendered stereotypes may not feature and that is also OK.

4. Word of warning (5')

Inform the students that, in the following workshop, they will prepare a draft of their monologues, which will be represented in front of their classmates.

PARTICIPATORY WORKSHOP 6: SCRIPT WRITING AND PERFORMING SKILLS II

Goal: To finish the script of the monologues.

Specific objectives:

- To search for scientific information to finish the script of the monologues.
- To write the final version of the monologues.

Students' skills and competences worked:

Learning to learn: ability to pursue and persist in learning, effective organisation (i.e. time and information management).

Social and civic competences: communication skills, collaborative skills, informed and reasoned decision-making, ability to resolve conflicts.

Sense of initiative and entrepreneurship: ability to turn ideas into action, self-confidence and esteem, ability to plan and manage projects.

Description of the activities:

Duration: 2h. Times showed in each activity are approximate and may vary depending on the loss of time due to students' organization into the room.

1. **Warming Activities (10')**

All stakeholders involved participate in the warming activities.

1.1. Dibi-di-Dabidi... BUM! (5')

Everyone gets in a circle. A person is inside the circle, and s/he approaches someone else to tell a sentence or a word. The person who receives the message must respond or take an action. If s/he makes a mistake, s/he moves to the centre of the circle. The messages may be, for instance, the following:

Person inside (PI): "Dibi-di-dábidi"

Person in the circle (PC): say "BUM" before the PI has finished saying Dibi-di-dábidi.

PI: "BUM"

PC: Must remain silent

PI: "Aviator"

PC: Hold fingers near the eyes like glasses; people on her/his side make the wings.

PI: "Toaster"

PC: Jump! People on the sides surround her/him with their arms

PI: "Damaged toaster"

PC: Stand still! People on the sides surround her/him with their arms and jump

PI: "Kebab"

PC: Turns on yourself. People on the sides pretend to cut meat

PI: (Say what you want)

PC: This person and people on the sides do something that relates to what has been said.

1.2. Eye contact (5')

Ask the entire group to randomly walk around the classroom. They must count how many 'good quality visual contacts' they can get as they move. We define 'good quality eye contact' when both persons look at each other directly in the eyes. Explain to the students the importance of the use of the gaze also in oral communication, and point out that they must take it into account when performing their monologues.

2. Script writing of the scientific monologues I (60')

If possible, this activity will be conducted in a computer room. Students, working in their SWGs, write the script of the monologue in a Word document, by:

- Recopying the notes of their PERFORM notebook
- Including new scientific content based on the activities done in PW4
- Including new situations related to the content of the PW5
- Early career researchers visit the SWGs and talk with the students in order to act as "critical friend", encouraging the students to reflect and facilitating conversations around reflection related to the scientific content of the monologues.

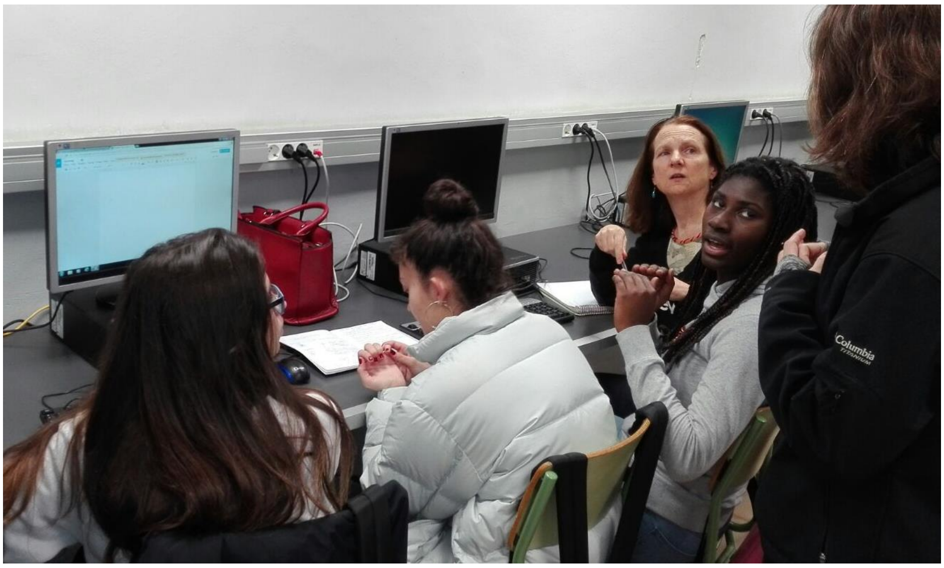

Figure 13. Students and researchers working in the scripts. School Moisès Broggi, Barcelona, Spain.

3. Review of the content already written (30')

Each SWG presents to the rest of the class the material they have up to that moment. Communicators, researchers, teachers and the rest of the students provide feedback about both the scientific content and RRI values of the monologue presented; highlighting, in particular, what is missing. The students must define what information they need to include in their monologues.

4. Script writing of the scientific monologues II (20')

Ask students to incorporate the received feedback into the scripts of their monologues. Finally, inform them that in one week they will present their monologues. Thus, it is time to finish the writing of the script and start learning it by heart.

PARTICIPATORY WORKSHOP 7: REHEARSAL

Goal: To rehearse the pieces of PERSEIA generated by the SWGs to get a global PERSEIA completely designed in all its dimensions: structure, script and dramatization.

Specific objectives:

- To provide students with techniques to learn by heart their scripts.
- To generate the global structure of the PERSEIA by working on teams, in order to establish the number of PERSEIA sketches, the storyline, and the role of each student.

Students' skills and competences worked:

Social and civic competences, or the ability to participate in an effective and constructive way in social life (i.e., team work, collaboration, social responsibility of science)

Sense of initiative and entrepreneurship, or the ability to turn ideas into action (i.e., creativity, critical thinking and innovation)

Learning to learn, or the ability to pursue and persist in learning and effectively organise and manage time and information (i.e., self-reflection, scientific method-approach)

Description of the activities:

1. Warming Activity (10')

All stakeholders involved participate in the warming activities.

Zip/zap:

On this activity, students have to focus on the actions and words said by others. To do so, students, teachers and researchers form a circle together with the facilitator. Firstly, the objective is to thrown an energy ball to each other following a precise protocol. The facilitator is the first one who launches the energy balls. When the energy ball is thrown to the person on the right, shout "ZIP", and “ZAP” if it is thrown to the left, and clap your hands in the direction of that person. To send the energy ball to someone else, point her/him and say "ZOOM!” followed by her/his name (e.g. “ZOOM Helena”). To send back the energy ball to the one who sent it, do the "wet cat" and say "FSCHH!!" to that person. They have to look at each other in each step. Secondly, the same activity is done by throwing a list of words (instead of an energy ball). The facilitator is the first one to speak; s/he looks at the one student and says a word that can be contained in a list (e.g. "RED" – list of colours). That student looks at another one, and says another word related to the first one (e.g. "BLUE"); this second student passes the list to a third one, and so on... The facilitator can send two or three list of words to the group, and the group has to make them circulate simultaneously (examples of lists: countries, cities, names, insults...). After a round, when the group is able to process at least two lists of words, the facilitator combines both games, throwing energy balls and making circulate lists of words at the same time.

This game is a metaphor for acting on a stage: the zip/zap protocol is the text they say to each other and that they have to process. The list of words is the unexpected things that can happen while focusing on the performance. In order to be sure that no one is alone in that, they have to look at each other constantly, listen and concentrate on each other.

2. Rehearsal individual activity (30')

Explain to the students that working 'by ideas' may be a useful strategy to learn their scripts by heart. They should analyse which ideas they want to transmit in their monologue, visualize them and string them together in their mind. Thus, the first step is to memorize the ideas that "will happen". Once the ideas are memorised, it is possible to learn the script. Let each student to work on it following the system s/he consider more suitable for her/himself, but give them following mechanism as an option:

i. Divide your script in paragraphs.
ii. Take the first one. Read some times and try to repeat in your mind without consulting the text.
iii. Once you can do it, try to repeat the text aloud, vocalising. Try to find difficult words or sentences and repeat it.
iv. Once you can do it, try to repeat the text aloud and dramatizing, performing (use body language, gesticulation, the look etc.)
v. Once you can do it, let's move to the second paragraph and repeat all the process.
vi. Once second paragraph is ready, try to dramatize both, first and second.
vii. Then, move to the third, and to the fourth… until all your script is rehearsed.

Split students in the SWGs, and to allow them to rehearse by using their own rehearse methods.

3. **Definition of the global structure of the final PERSEIA (15')**

To get the global structure of the PERSEIA is necessary to:

- Define whether there will be (or not) a presenter to conduct the show, and who will play that role (teacher, researchers, SciCom or students themselves).
- Decide how many monologues are going to be done in each group, depending on the necessities and intentions of the students.
- Define the order of the monologues.

4. **Global rehearsal (55')**

Each SWG rehearses its individual monologue generating the final PERSEIA in which all monologues are integrated, following the structure defined in the previous section. Teacher/s, researchers, and SciCommer/s give feedback and highlight student's strengths.

5. **Homework**

Rehearse, rehearse, and rehearse!

PERSEIA DELIVERY

This closing stage lasts for 2h. During the 1st hour, students rehearse without audience to get used to the stage elements. Technical feedback is provided by the performers (e.g. positions in the space, voice, order, etc.). After that, the audience (e.g. other classmates) come in and the show begins! Once the audience is accommodated, the SciCommer/s explain (very briefly) that these monologues have been produced in the context of a EU project that aims to foster participatory engagement with science and technology through performance. Next, two students take the role of presenters and introduce each monologue, the monologists, and the researchers who have helped the students. Alternatively, researchers may introduce each of the sketches. At the end of the show, the SciCommer/s close the project, thanking the participation of all the stakeholders involved in the participatory project (i.e. students, teacher/s, researchers, and SciCommer/s). Finally, it is strongly recommended that students present their final PERSEIAs in the most "professional way" possible. For instance:

- Setting up a stage, for example, in the school auditorium.
- If a projector is available, some group images can be shown during the show, in which participant students, teacher/s, researchers, and SciCommer/s appear.
- Make use of microphones and spotlights and, if possible, incorporate music when the performers come on and out of scene. These elements generate a sense of "professionalism" that makes the process more enjoyable for the participants and the audience.

Figure 14. Presentation of the final PERSEIAs at the school Moisès Broggi, Barcelona, Spain.

Figure 15. Presentation of the final PERSEIAs at the school Consell de Cent, Barcelona, Spain.

4.2. Science busking by Science Made Simple (SMS) in the UK

Main goal of this approach:

This approach aims to meet the needs of school students, ECRs and teachers related to science learning and teaching by considering the ECR training and PW holistically - as one shared journey. These activities encourage students and ECRs alike to ask questions, reflect on their own and other contributors' thoughts, preconceptions and attitudes towards science.

Specific Objectives:

- To engage researchers, students and final performance (PERSEIA) audiences in science related to researchers' work.
- To support ECRs in the interpretation of their research for the school - and ultimately public – audience.
- To encourage active participation of students in busking methods early in the PW process.
- To ensure ECR content is fully used throughout processes with students.
- To encourage active participation from teachers.

Methodology:

Four workshops are held in secondary schools, each of 3 hours' duration (Figure 16). The workshops take ECRs, students and teachers through a process in order to develop science busking routines, which engage audiences in the topics of the ECRs' research. The busks are developed through a collaborative process between ECRs and students and topics are chosen and subject matter included through a process led by the interest and motivations of students.

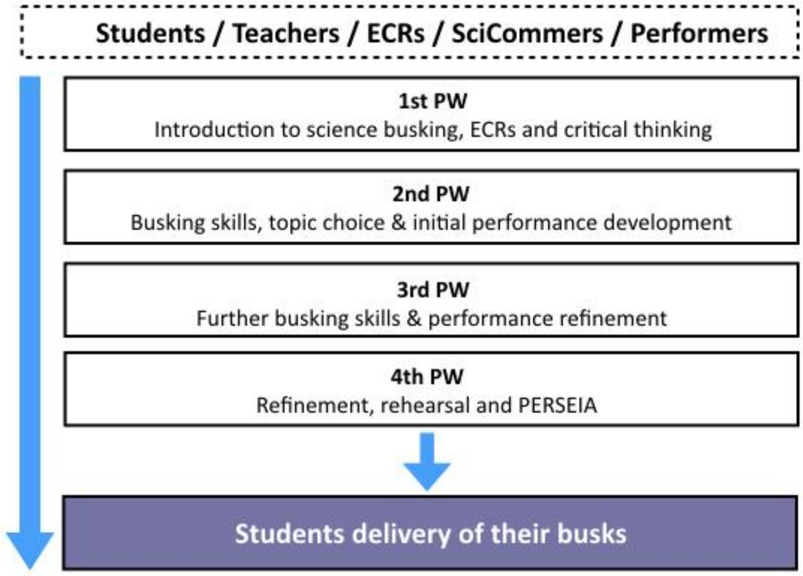

Figure 16. Series of Participatory Workshops (PWs) as implemented in the UK.

Venue requirements and material:

- A room with tables in cabaret layout sufficient for approx. 5 groups of three or four, sufficient for students to work in groups with an ECR.
- Enough room to move from the tables to do some light physical activity. A double classroom with one end cleared of tables, or a drama studio with tables and chairs added at one end is ideal.
- A 'top table' for display of busking materials.
- PowerPoint presentation facilities.
- Basic everyday equipment is provided to create props for the busks; this is sourced by ECRs, but guided by students and science communicators.

Some considerations before starting:

- The ideal size of the group of students is between 9 and 15. Therefore, if there are more students in the class, it should be split into 2 groups.
- The ideal size of the small working groups is 3-4 students.
- Together with facilitators and teachers, Early Career Researchers (ECRs) should follow a brief training, in order to learn how to popularize their scientific work and to best prepare their interventions during the workshops.

Participatory Workshop 1: Introduction to science busking, ECRs and critical thinking

Goal: Students understand the PERFORM project as a whole. Students choose a scientific topic they want to explore and link this issue with the European Union Societal Challenges (EU-SC). By the end of this session, students will have a good sense of what is expected of them through the project, what the roles of each person in the room are, and what students will produce at the end. They will have learned something about the research of at least one ECR and considered that research in relation to EU societal challenges.

Specific objectives:

- To assist students to understand the overall project, the importance of generating a PERSEIA and the steps to be followed: Explanation of how PWs will be implemented, indicating that group work will be done during the workshops;
- To introduce and illustrate the concept of science busking;
- To make students aware of the relationship between different scientific areas, the EU-SC and STEM-Jobs, giving them tools to choose scientific content of their PERSEIA sketch;
- To establish groups and PERSEIA topic selection.
- To know that scientific research is a social practice.

Description of the activities:

1. **Sample of science busking show - whoopee cushion (10')**

Science Communicator/s introduce to pupils a strong example of science busking, and the elements of a performance that go together to make a successful science busking performance.

2. **Introduction to project (5')**

Short intro to project overall. Science Communicator/s describe what will happen over the four weeks.

3. **Introduction from other contributors (5')**

If they have not already spoken and introduced themselves facilitators and teachers introduce themselves and their roles in the project.

4. **ECR Elevator pitches (10')**

Each ECR gives a short elevator pitch to the whole group.
Students are placed in groups if not already set and one ECR is allocated.

5. **Research a Researcher (45') (see Annex 4)**

ECRs work with student groups to lead students into thinking about societal challenges. ECRs make short informal presentation to their student group. Presentation to include:

- Science content
- Setting the scene of where their science takes place
- Personal information (motivation, what kind of person they are)

- Reason why their research is taking place

Students receive blank index cards on which to write one thing about the ECR for each of points a-d above. These points supplemented by further points for consideration on PowerPoint slide relating to societal values of research, problems they solve, contentious issues.

Student groups introduce their ECR to the whole class.

Assistant facilitator summarises societal challenges mentioned on one flip chart sheet. Scientists and politicians call these societal challenges NB Explain the term 'societal challenge' as 'world problems' or avoid the term, as appropriate for the group.

Students discuss in groups for one minute to think of other world problems that science works to help with. Facilitator takes one example from each group and adds to the flip chart sheet.

6. **BREAK (15')**
7. **Warm-up exercise (10')**

Good performances stem from having lots of energy and concentration. Warm ups exercises can help give us the energy and concentration we require. Pupils, ECRs, teachers and trainers all participate.

- Write your name. Stand in a circle and write your full name in the air with your right index finger, then left index finger, then right big toe, then left big toe and then with your bottom.
- Rubber chicken. Stand in a circle, wave your right hand 5 times in the air, then left hand, then left foot, then right foot. Repeat for 4 times, then 3 times, then 2, then 1. Jump in the air shouting 'rubber chicken!'

8. **Glovaphone stories (20')**

Science Communicator/s and students study the components of a very successful busk around the science of sound. This will be achieved by the pupils making part of this demonstration themselves as a make and take activity. Science Communicator/s will ask questions to help students reflect on what they are doing, to suggest improvement. This will serve to get a taste of reflective practice in anticipation of the next exercise.

9. **Introduction to reflective thinking concept (5')**
10. **Reflective thinking exercise based on ECR busks (45')**

Facilitators/SciComm and ECRs will each present their busks to the whole group. Students will then be asked to brainstorm what elements help this busking performance achieve its goals.

11. **Conclusions – recap on learning, next steps**

END

Homework (optional for students, essential for ECRs) – students are not set homework in UK schools but students are invited to seek out news items relating to research discussed in the workshop, and bring articles to PW2. The news items can come in whatever form the students want – blogs and vlogs, traditional newspaper, references to TV/YouTube programme.

Participatory Workshop 2: Busking skills, topic choice and initial performance development

Goal: To approach the scientific content and concepts previously addressed in the workshops through the lens of science busking. Students will develop the core theme of their science busk and will start thinking about its demo elements. By the end of this session, students will have decided what their busks will be and ECRs will know what props are required.

Specific objectives:

- To identify connections between scientific research and artistic practice;
- To identify considerations in recognising responsible research communication;
- To gain communication skills about explaining their chosen science concept to others;
- To start building a theme and script for their science busks;
- To start learning presenting skills through improvisation and working with props.

Description of the activities:

1. **Welcome and recap from last workshop (5')**

Place students in groups established in previous workshop.

2. **Deconstruct a busk – Pete the Rabbit (15')**

Science Communicator/s give an example of busk and deconstruct exercise. Pupils deconstruct a longer example of a busk to better understand what a busk is and the techniques that they could use in their own science busk. ECRs work with groups.

3. **Secrets of good busking (20')**

Exercises relating to good busking technique – e.g. eye contact, use of space, holding props (See PW3 for examples).

4. **Mystery busk practice (30')**

In your group, tell us a story about your object. Groups are assigned random items around which they have to create and perform a short story, so as to begin to give the pupils some experience of what it is like to sand up in front of an audience and busk.

5. **BREAK (15')**
6. **News about science exercise (35')**

SciCommers/facilitators to lead, **ECR**s to lead each group. ECRs provide their groups with 2+ news items related to their research. They lead a discussion with their group which encourages students to think critically about the content of each item, paying particular attention to reliable sources and the effect on audience of presentation and content.

7. **Creating new busks (30')**

Science Communicator/s to start, **ECRs** to lead groups. ECRs and students work together in small groups to start creating busk ideas:

- 15 mins to come up with potential ideas in groups
- 10 mins for discussion of ideas in groups
- 5 mins individual groups vote on the idea they would like to create a busk around.

ECR to have the casting vote on final busk chosen.

Science Communicators and teachers to record each group's participants, busk title/idea, props list.

8. **Reflective thinking exercise (10')**

Science Communicator/facilitator to lead. Feedback from the first year of PWs suggested that telling students, particularly female students, about the challenges faced by women in science actually made them less likely to consider themselves as future scientists. As a result, we have decided that we will not be delivering a specific session on gender and stereotypes, but will rather be addressing these issues as they arise, through reflective thinking.

This will be achieved through ECR training, preparing ECR to model being a 'reflective friend'. The concept of the reflective friend means creating a supportive but critical environment, in which people feel able to raise questions or concerns about any aspect of how things are being portrayed in performances. It is through this mechanism, within reflection sessions, that these issues around gender and stereotyping will be approached.

9. **Present idea & reflections to group (15')**

Students present their busk ideas to the whole group. Whole group reflects on ideas.

10. **Conclusions – recap and next steps (5')**

END

Before PW3 – **ECRs** to procure props with assistance from science communicators (extra budget might be required). Students are invited to bring in items too, but there is not requirement.

Participatory Workshop 3: Further busking skills and performance refinement

Goal: To stage and dramatize the script of each science busk. To develop each science busk, allocating roles to group members, refining equipment lists and noting a bullet-point script. By the end of this session, students will be confident that they have a busk to perform with suitable props during PW4. They will have reflected on its quality and implemented changes. They will consider adaptations required for the specific environment of their PERSEIA.

Specific objectives:

- Teams have so far chosen a topic for their science busk. Some teams have clear ideas but others are less defined. All teams will have clear ideas by the end of this workshop;
- Teams should have a written script for their science busk and a plan for which team member will be doing which part of the performance;
- To learn exercises and tools which will help them to perform their science busks.

NOTES: This workshop follows a timetable more loosely than the previous two workshops, allowing the atmosphere and pace created by the students' work to shape it. Timings are approximate, and exercises place in to the workshop to punctuate the proceedings, and change focus and pace. The aim of the workshop in terms of atmosphere is to ensure that a sense of excitement and a clear plan for PERSEIAS is established among students and ECRs.

Description of the activities:

1. **Busk example – sitting on a balloon (15')**

Science Communicator/s tell the story of how this busk was developed by a researcher to attract audiences to deliver aspect of his science.

2. **Warm up – rubber chicken** (See PW1)
3. **Recap on previous workshops**

The following points should be mentioned:

Team topics were chosen and you have been thinking about how you might present them to an audience

Critical thinking/reliable sources

This moment should be used to emphasise that their busks will be only about 5 minutes long and will need to be interactive in some way.

4. **Busking development #1 (30')**

- What do we have so far? (10')

ECR's, teachers and science communicators work with the busking groups and help them to re-cap on what they have generated up to now.

- Busking Planning (20')

Each team will be asked to generate a bullet pointed busking plan. This should include:

- How will you get your audience involved?
- A beginning, middle and end to your busk.
- If you have a prop what will it be and how will you use it in the busk
- Who will do what in the busk

Adults with each group should make notes so that students can work from them later.

Science Communicators rotate around the room working with each team to ensure that they have some ideas.

5. **Good busking techniques (30')**

A selection of exercises to help students and ECRs focus on the techniques required to gather, engage, encourage and entertain an audience. Exercises used will depend on the time available, group size and the particular areas of busking technique that require work for that particular group:

- **In my house**... (10')

Science communicators present a two-minute tour of their houses demonstrating good and bad performing styles.

Presenter 1 presents a bad version by folding arms, reading a script, lots of "ums", no eye contact, no smiling, a list, boring information etc. Presenter 2 then presents a good version lots of eye contact, smiling, interesting, descriptive, confidently, no script, humour, engaging etc.

Students then discuss what each presenter did and form a list of good presenting tips.

- **Smiling exercises (8')**

Two short exercises to get people smiling and communicating.

- Introduce yourself to the person next to you. Three pieces of information should be shared. Note how you both smile at each other.
- Tactile illusion where you join hands with the person next to you and one person runs their thumb and forefinger up and down on of the joint fingers. It feels strange but makes you laugh and smile.

Take home message – smile at your audience. By smiling you are increasing the chance that you are engaging people.

- **Eye contact exercises (8')**

Short activities illustrating the importance of good eye contact.

- This exercise works better with larger groups. Everyone walks around the room making eye contact with as many people as they can. DP points out good and not so good eye contact. Note how you often smile as you do it. This is repeated with students counting the number of eye contacts made. The highest gets a prize.
- This exercise works better with smaller groups. DP presents a short talk to the group. While he does, each group member raises one hand slowly until DP makes good eye contact with them. They then drop their arm and begin again. If DP does not make eye contact the group member continues to raise their arm, making beeping noises as it gets higher.
- The aim is for DP to make good eye contact with every person in the room, thereby keeping everyone's arm low and no beeping.

Take home message - eye contact is important for making your audience feel like part of the activity or science busk.

- **Whispering Game (8')**

A message is whispered by DP to one person who passes it on to their neighbour. It can only go in one direction and they cannot repeat it. This continues around a group and the last person repeats what they heard.

This activity shows the importance of good communication and how communication often goes both ways. Questions and answers. Also listening to each other and making sure you understand.

- **Save the World (20')**

Groups reach into a box of their props and choose just one. They use this cue item to tell the whole group (or in smaller groups) a story of how this object saved the world. This is an opportunity for the groups to practice their busking techniques in a friendly and upbeat environment.

6. **Busking development #2 (20')**

Science Communicator to introduce two or three possible PERSEIA scenarios, with different venues, audiences and therefore parameters to consider. Students reflect on these and offer suggestions as to what should be considered for the different scenarios, and consider how they may need to adapt their busks to fit the scenarios. One of these scenarios should be the one which is the chosen PERSEIA environment for that group.

7. **BREAK** (10')
8. **Practice your lines (15')**

Groups and ECRs work together to rehearse. Teachers, science communicators and ECR trainers rotate around the groups to support.

9. **Present to the whole group (25')**

Each busking group will present their busk to the whole class; class to reflect on each busk, offering ideas for improvement, thoughts on style.

10. **Formative assessment exercise (20')**

See PW1.

11. **Conclusions – recap on learning. Next steps (5')**

END

PW4: Refinement, rehearsal and PERSEIA

Goal: Students rehearse their busks, ensure their props and costumes are in order and can be easily carried to the PERSEIA location. They will then travel to their PERSEIA location and perform their busks.

By the end of this session, students will have completed their PERSEIA and reflected on the PERSEIA experience and their participation in the project overall.

Specific objectives:

- To rehearse busks with ECRs, teachers and science communicators to support
- To collate all props, costumes and equipment
- To transport students ad props to the PERSEIA location
- To execute the PERSEIA
- To summarise and reflect on PERSEIA and project process
- To thank all contributors and mark the project end.

Description of the activities:

Timetable for PW 4 is loose and very much dependent on the PERSEIA chosen for each school, the need to allocate travel time and the constraints placed by the PERSEIA venue.

Below is an approximate timetable and tasks but this was different in each school in the UK due to e.g. primary school and PW school finishing times, distance between schools.

1. **Set the mood (10')**

Science Communicator/s perform a short busk to establish an atmosphere of fun and anticipation, and to recap on busking techniques learned about through the pervious PWs.

2. **Order of the PW (5')**

Science Communicator/s present to the participants the order of activity for the PW and PERSEIA. Time is tight and all participants need to remain focussed on their tasks.

3. **Final rehearsal (30')**

Groups practice their busks for the last time before the PERSEIA, paying particular attention to ensuring each group member knows their role, is familiar with the prop/s they are using and the lines they are saying.

4. **PERSEIA preparation (5')**

SciCommers, ECRs, teachers and ECR trainers help students to take their places. SciCommers talk to PERSEIA host and audience, so that they understand what will happen and what their roles are.

5. **PERSEIA (30')**

Students perform their busks to the audience for around 30 mins, or as long as the PERSEIA host allows.

6. **Reflective Session (30')**

An informal session, allowing all participants opportunity to reflect on and share their experience of performing their busks in front of an audience.

SciCommers/facilitators thank teachers, students and ECRs for their participation.

END

Figure 17. Presentation of the final PERSEIAs at Bristol Free School, in Bristol (UK).

Figure 18. Presentation of the final PERSEIAs at Bridge Learning Campus, in Bristol (UK).

4.3. Clown and improvisation theatre by TRACES in France

Main goal of this approach:

Creativity is absolutely important on improvisation. Driving students, teachers and ECRs through the world of the creative clowns to generate scientific sketches will encourage students and ECRs alike to ask questions, reflect on their own and other contributors' thoughts, preconceptions and attitudes, at the same time that they generate a complete theatrical play talking not only about scientific content, but also about the human dimension of science.

Specific Objectives:

- To assist students to understand the overall project, the importance of generating a PERSEIA and the steps to be followed: Explanation of how PWs will be implemented, indicating that group work will be done during the workshops;
- Introduce and illustrate the concept of science busking;
- Make students aware of the relationship between different scientific areas, the EU-SC and STEM-Jobs, giving them tools to choose scientific content of their PERSEIA sketch;
- Establish groups and PERSEIA topic selection.
- To understand that scientific research is a social practice.

Methodology:

Seven workshops are held in secondary schools, each of 1h30 to 2 hours' duration (Figure 19). The workshops take ECRs, students and teachers through a process in order to develop improvisation scenes. The sketches are developed through a collaborative process between ECRs, performers and students and topics are chosen and subject matter included through a process led by the interest and motivations of students.

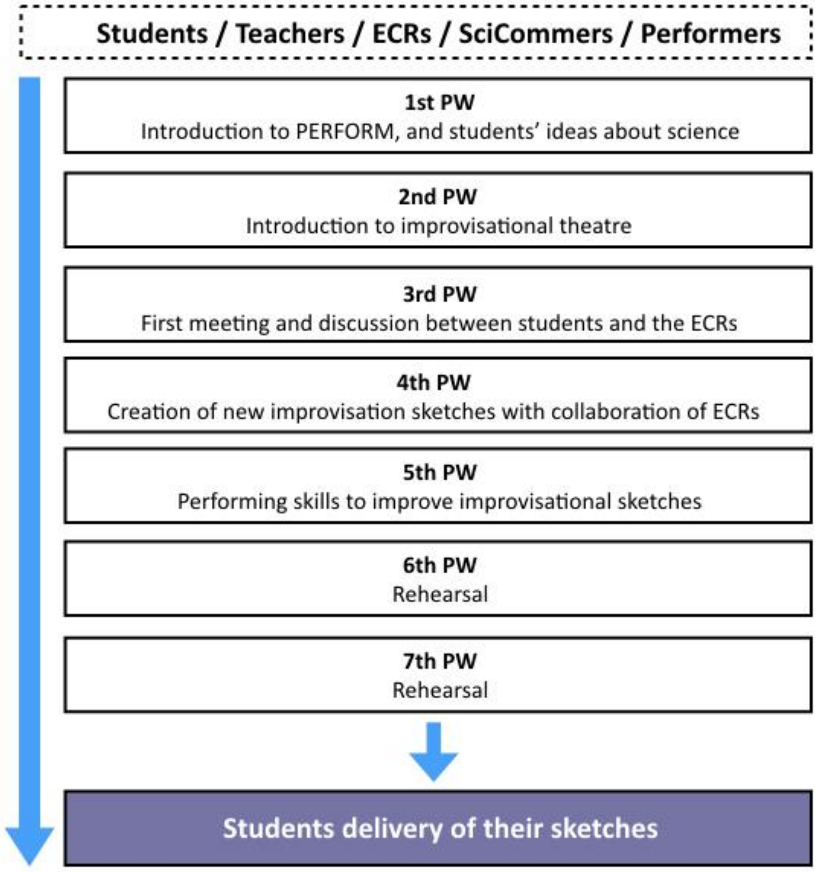

Figure 19. Series of Participatory Workshops (PWs) as implemented in France.

Venue requirements and material:

- A room with tables in cabaret layout sufficient for approx. 5 groups of three or four, sufficient for students to work in groups with an ECR.
- Enough room to move from the tables to do some light physical activity. A double classroom with one end cleared of tables, or a drama studio with tables and chairs added at one end is ideal.
- A 'top table' for display of busking materials.
- PowerPoint presentation facilities.

Some considerations before starting:

- The ideal size of the group of students is between 10 and 14. Therefore, if there are more students in the class, it should be split into 2 groups.
- Teachers are encouraged to work with the students between two participatory workshops (PWs), in order to refresh the students' knowledge.
- Together with facilitators and teachers, Early Career Researchers (ECRs) should follow a brief training, in order to learn how to popularize their scientific work and to best prepare their interventions during the workshops. ECRs are required to join the PWs from PW3, not before.

PARTICIPATORY WORKSHOP 1

Goals: To prepare the students for their upcoming meeting and discussions with the ECRs; to explain concretely the PERFORM project to the students; to collect and gather students' ideas and thoughts on science and on ECRs' research topics.

Specific objectives:

- To prepare and facilitate the meetings between the students and the ECRs.
- To collect students' raw thoughts and knowledge about scientific research; gauge and estimate their scientific literacy and the state of their knowledge about scientific research.
- To gather students' thoughts about what may the day of an ECR looks like.
- To show how science, scientific theories and scientific discoveries can be questioned and are continuously changing with the years and centuries.

Students' skills and competences worked:

Learn to trust other people.

Exceed your own limits and ambition.

Collaboration (working with others), imagination, reflections, cooperation, perseverance.

Description of the activities:

Material Needed: A tennis ball, a chronometer, photos and pictures (related to PERFORM project; e.g. pictures related to science, theatre, Europe countries, collaboration, etc.), large sheets of paper, pencils, blue tack.

1. **Presentation of the PERFORM project (5')**

The facilitator simply explains the global objectives of the PERFORM project.

2. Warm-up and theatre exercises (30')

Exercise 1: The quickest path

Students stand in a circle. One student throw the ball to another, who should not be one of his neighbours, and says his/her first name at the same time. Each student must receive and throw the ball only once, and every student must participate. At the end, the ball must be back in the hands of the first player.
When a logical path for the ball is found, all students try to do it again, exactly in the same order, without saying their first names. Then, they have to do it quicker and quicker: in 15 seconds, 10 seconds, 5 seconds and 3 seconds.
A chronometer should come in handy!
The ball has to follow always the same path: the same order of students. Hence the students have to find different solutions for the ball exchange to go faster. However, the subtlety is that, at this point of the game, the rule forbidding throwing the ball to a neighbour is lifted.
The facilitator can draw conclusions and make connections with science and research:
Which skills did you use?
Collaboration, imagination, reflections, cooperation, perseverance, mobility, etc.
You need to rethink and reorganized your methodology in order to improve your performance, even with some constraints.
We are stronger in a group; we are when we work together.
In order for the whole group to feel/believe that they can face the challenge, it's important to think as a group and cooperate step by step.

Exercise 2: Body coordination and concentration

Students walk randomly in the classroom, without bumping into each other.
Following the instructions of the facilitators (announcement of numbers, for example), students must stop (N°1), walk slowly (N° 2), walk normally (N° 3) and walk really fast (N°4). Then the students must stop completely, stay where they stood when they stopped, and close their eyes.
While they still have their eyes closed, the facilitator asks a question to each student:
How many windows does this classroom have?
How is your teacher dressed?
What are the posters on the walls of the room about?

The facilitator can draw conclusions and make connections with science and research: Sense of observation, attention to detail.
Concentration.
Then, ask the students to lie on the floor and to stand up, in: 8 times/beats, 6 times, 4 times, 2 times, 2 times, 8 times
The aim of this exercise is to work on body coordination of the.

Exercise 3: The circle of words

Students make a circle. The facilitator stands in the middle and points one student after another, randomly: each of them has to say a word, related to a given topic, and is not allowed to say a word that has already been said.
You can start without eliminating anyone, but once the game is understood, you can start to eliminate students when they « fail » to find a relevant word.
Topics that can be chosen: Science, Nature, Lab, Research, etc.
This exercise helps the students, in a recreational way, to emerge themselves into the project and to get used to a vocabulary that they do not hear or use often.

3. Express and discuss about PERFORM, using photos and pictures (20')

The aim of this activity is to go deeper into the students' understanding of the PERFORM project, using concrete pictures and using the words and vocabulary used by the students themselves.
Each student chooses 2 or 3 pictures, spread on a table. Each picture is related to the PERFORM project.
Some criteria given to the students to help them choose the pictures: The one that you like, that you don't understand, that surprise you, etc.
Each student then explains why he has chosen these pictures, what they think is interesting in these pictures.
After each picture presentation by a student, the facilitator explains why/how it's linked to the PERFORM project.

4. Collect students' ideas using mind maps (35')

The facilitator hangs 3 large sheets of white paper on the wall or on the blackboard.
On the first poster, the facilitator writes the question « What is scientific research? », in the middle of the sheet.
On the second one: « What is/could be a daily life of a researcher? »
On the third one: « What are the main ideas that come to your mind about the research topic of the ECR? »

The facilitator asks the students to say whatever comes to their minds, for each question. The group starts with the first question on the first poster, and the facilitator writes down all the ideas and words that the students say, without any filters.

At the end, the facilitator explains to the students that these mind-maps will be used during the next workshops as a starting point for impro theatre exercises, and that at the end of the project, they will do these mind-maps again, in order for them to compare the 6 mind-maps (Figure 20).

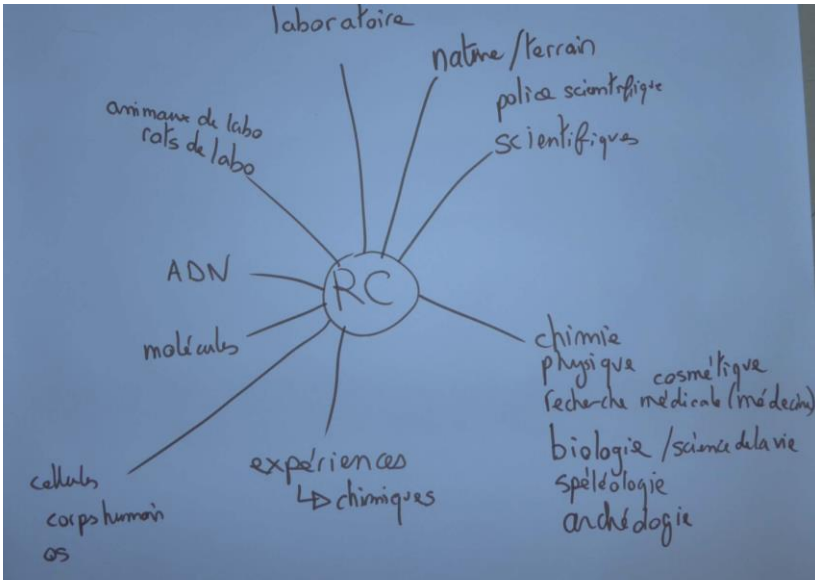

Figure 20. Example of mind map created by the students.

Participatory Workshop 2

Goals: To prepare some short impro sketches that will be played in front of the ECR, during the PW3, in order to prepare the students to this meeting.

Specific objectives:

- To prepare and facilitate the upcoming meeting between the students and the ECR. Start playing and acting, using impro theatre technics.
- To feel more confortable while playing and acting.

Students' skills and competences worked:

Collaboration and cooperation.

Listen to each other.

To feel comfortable with body coordination exercises.

Description of the activities:

Material Needed: a string, 2 bowls, 1 stick, fabric, a balloon, and any kind of objects you want.

1. **Introduction (5')**

The facilitator asks the students to explain what they have understood or what they remember from the explanations of the PERFORM project from last PW: depending on what their answers are, it's really important to clarify or precise the vague points.

2. **Warm-up activities (35')**

Exercise 1: The brain and the body

The students stand up and form a large circle. The first student has to say his/her first name, followed by a gesture and a sound. The following student has to repeat it (first name of 'student 1' + gesture + sound) and then say his own name, followed by a gesture and a sound of his choice (different than those of 'student 1'. The third student has to repeat the names, gestures and sounds of 'student 1' and 'student 2', followed by his/her own name, gesture and sound. And so on and so forth.

Exercise 2: Body coordination

All the students walk randomly in the classroom, without bumping into each other. Students must then stop, stay where they stand and close their eyes.
The facilitator ask the students to lie on the floor and then to stand up, in:
8 times/beats, 6 times, 4 times, 2 times, 2 times, 8 times.

Exercise 3: Imagination and spontaneity

The facilitator installs several objects (string, bowls, stick, fabric, a balloon) on the floor, in the middle of the room. Students form a large circle around the objects. The facilitator explains to the students that they have to choose an item, walk quickly toward it, pick it up, and play/mime something with this item that is absolutely not related to its primary function.
For example: If one chooses the balloon, he can mime as if the balloon was a phone, but he cannot use it as a football balloon.
Then, the student must put back the object on the floor in the middle of the circle, and go back to his spot within the circle, thus enabling another student to perform a mime with one of the items, following the same process.
This activity can also be done with objects related to science. Or it can be organized during another workshop with objects related to science.

3. Frozen photos (20')

This activity aims to move slowly to impro sketches.

The facilitator has to write down on small piece of paper different topics that will be enacted by the students, as if someone took a photo of them: they must not move at all.

Topics of these frozen photos should be related to what came out from the mind-maps (forensic science / into the human body / etc.)

The group can be split into smaller groups of 5 students.

The first group draws a paper and reads it. Within this group, the first student to have an idea about who or what he's going to embodied walks as fast as possible to the middle of the room or the stage, poses following his idea and has to say, distinctively: « I am... » (for example, if the theme is "forensic sciences", the first student can say "I am the dead body").

A second student does the same, imagining something linked to what the first student did, thus completing the picture . And so on and so forth.

Then, the facilitator takes a picture of the « frozen photo ».

The first group can draw a few papers/themes and realizes several « frozen photos » before handing over to the second group.

4. Theatre improvisations (50')

The group is split into smaller groups of 4 students.

The facilitator has to write down on pieces of paper different improvisation topics. The topics are related to what came out of the mind-maps, and to the ECRs' research topics. Facilitators have to brainstorm about these topics before the workshop, in order to find some really accurate and specific topics, related to what the students have said.

Example: As one ECR was working on empathy, students shared about the meaning of empathy and about being able to put oneself in the shoes of disabled people. After discussion, facilitators decided to name the impro topic as: « Imagine the day of someone in a wheelchair ».

Each group has to draw a topic and has 5' to prepare a short improvisation scene. Then, each group has to play it in front of the other students.

The facilitator warns the students that they will play these short improvisation scenes in front of the ECR(s), during PW3.

PARTICIPATORY WORKSHOP 3

Goals: To compare what the students thought about scientific research with the reality, by discussing with the ECR; to start the collaboration between the ECRs and the students; to allow the ECRs to explain their works, their daily life, their curriculum, etc.

Specific objectives:

- First meeting and discussions between the students and the ECR(s)
- Demystify the world of science and research.
- Perform (maybe for the first time) in front of unknown persons.
- Stimulate the curiosity of the students and their will to ask questions and to discuss with the ECR.

Students' skills and competences worked:

Curiosity.
Take into account that everybody has stereotypes.
Discuss and debate with unknown people, with adults.

Description of the activities:

ECRs should participate in all the activities, with the students.
Material Needed: Depends on the improvisations themes and on what the ECRs will bring to illustrate their scientific research. Ideally, the ECRs should bring some objects, some photos, and some videos of their daily work. A device to play music.

1. **Warm-up activities (30')**

Exercise 1: Samouraï

To warm up physically and vocally and get in touch with impulses; to get energized and excited about impro; to let loose and let go of inhibitions.
Students stand in a circle. Each creates a Samurai "sword" by putting their hands together, palm-to-palm.
Raising his/her "sword" above his/her head, an improviser lets out a classic ninja yell and brings his/her hands down, "stabbing" across the circle at another improviser.
When the first Samurai has their "sword" up, the other Samurais to his/her right and left have an opportunity to use their own "swords" to stab the first Samurai's soft underbelly. They will let out a yell when they do so, bringing their arm-swords across the first Samurai's belly in a lateral motion (they do not actually touch the person, just cut across).
Once the "stab" has been passed, the receiver will raise their sword and let out a yell while passing the stab to another player. The players on his/her left will attack the players belly while shouting, as with the first Samurai.
The game continues until players are thoroughly warmed-up and stimulated.

Exercise 2: Walks

Students walk randomly in the classroom, without bumping into each other. The facilitator defines a way of walking, loudly:
Walk really neutral
Walk like yourself
Walk like a caricature of yourself
Walk like an old woman or man
Walk like a child who just learnt how to walk
Walk like a robot
And, at the end: Walk in slow motion, with music.

2. Presentation of the improvisation scenes prepared by the students (45')

Students play the small sketches they imagined and prepared during the last PW, in front of the ECR, in order for her/him to discover what students have in mind when talking about science and research.
Discussion between the students and the ECR (1 obligation: The first question or thought must be pronounced by a student).
To enhance the contents of the discussion, the ECR will have prepared (especially during the ECR training) some pictures, some small movies, some objects related to her/his work and illustrating some parts of her/his daily professional routine.
Furthermore, during this discussion, the ECR will approach some of the PERFORM key topics, linked to her/his own experience: gender, ethics, critical thinking, etc.
And, last but not least, the ECRs will present and lead the short games that they have prepared during their ECR training, related to their own research topics.
At the end of the PW, the facilitator explains to the students and the ECRs that they will have some time, during the next PW, to ask some more questions that could come into their minds in between the 2 PWs or to discuss about some new topics that they want to approach.

Participatory Workshop 4

Goals: To build new improvisation scenes, together with the ECRs and the students; to use the material brought by the ECRs, and the discussions that happened during the PW3 in order to draw new ideas for the creation of new improvisations.

Specific objectives:

- To build trust between students and ECRs
- To remind the group that they will play a final play in front of people, at the end of

the project

- To improve body coordination and theatre skills

<u>Students' skills and competences worked:</u>

Collaboration

Trust in acting and sharing ideas with adults

Body coordination

Self-esteem

<u>Description of the activities:</u>

Material Needed: Scarves (enough to blindfold half a group of ≥ 10 students), materials to touch and smell (cinnamon, wool, silk, coffee, etc.).

1. **Continuation of the discussion between the ECRs and the students (30')**

ECRs can bring more objects, pictures or materials from their work, from their research. Students can have some more and new questions for the ECRs. This can be prepared by the teachers between PW3 and PW4.

ECRs can, as well, have questions for the students, about their studies, their experience with science, and their daily routine.

2. **Warm-up activities (30')**

Exercise 1: Body coordination and concentration

Students stand in circle. The first one says « 1 », the second one says « 2 », etc., but instead of saying « 8 », the eight student claps in his hands. Then, the following student starts again by saying « 1 ».

It has to go faster and faster. At some point, the facilitator can start to exclude the ones who got it wrong.

Exercise 2: The science circle of words

Students stand in a circle. The facilitator stands in the middle and points at one student after the other, randomly: each of them has to say a word, related to a given topic, and is not allowed to say a word that has already been said.

Facilitators can start without eliminating participants, but once the game is fully understood, they can start to exclude participants who failed to find a relevant word.

For the second round of this exercise, the theme is chosen in relation to the ECRs' research topic.

This exercise helps the students, in a recreational way, to immerse themselves further into the project and appropriate words that they do not hear or use very often.

Exercise 3 – Trust your guide

Participants split into groups of two. One puts a scarf on his eyes. The other one becomes his guide. The person who has a scarf on his eyes has to walk in the room. The other one guides him without putting his partner in danger. During this exercise, the guide makes touching and smelling items to the blindfolded person (coffee, cinnamon, fabrics, objects...). After a few minutes, the roles are switched.

3. Final circle

The facilitator runs a final discussion to elaborate the scenario of the final play: Which improvisations shall they keep?
Which topics do they like?
Which improvisations should be improved?

PARTICIPATORY WORKSHOP 5

Goals: To improve and work on the theatre part of the project, in order to practice and rehearse the play; to compare improvisation scenes between the 2 groups (if there are 2 groups), in order to create a constructive and positive emulation.

Specific objectives:

- To strengthen the group's cohesion.
- To strengthen the cooperation, and thus the discussion, between the ECRs and the students.

Students' skills and competences worked:

Feel completely involved in and part of a project
Trust
Cooperation
Observation and tolerance

Description of the activities:

Material Needed: Depends on the themes of the improvisation scenes.

1. Collective and common warm-up gathering the 2 groups (entire class) (30')

The facilitator can use any activity or exercise already performed in the previous PWs and mentioned above. Especially those that the groups really enjoyed.

2. Improvisations scenes (30')

Each group shows the improvisation scenes that they have been working on during the previous workshops.

After each presentation, an open a free discussion can lead.

After this collective workshop, each group return to their classroom.

3. Improvement of the scenes (40')

Work on the improvisations, keeping the final play in the crosshairs.

PARTICIPATORY WORKSHOPS 6 & 7

Students rehearse their scenes.

PERSEIA DELIVERY

Representation of the final PERSEIAs in the theatre

5. CONCLUSION

After the implementation of the PERFORM' participatory process described here, as science communicators involved in the design and implementation of the activities, we conclude that the objective of designing and testing **an interactive and transformative participatory educational process by using science and arts-based education approaches** has been achieved. The participatory process has been a rich experience for all the actors involved in the process and can be replicated in a vast diversity of European countries and educational contexts. We here present a wide offer of activities, based on three different artistic approaches, that allow students, scientists, teachers and science communicators/performers sharing the passion for science and the values embedded on the responsible scientific research through an artistic exploration. Following this collection of protocols of tested methods we are providing the scientific and educational communities with innovative tools to put students, teachers and scientists to work collaboratively through an artistic process. These tools drive them through STEAM (STEM+arts) education at school settings in an attempt to raise students' scientific vocations through innovative and creative approaches.

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ANNEXES

Annex 1. Material for the PW “Topic selection”

Scientists	Bullets	Text
Molecular Biologist	• S/he knows the cells at their molecular level • S/he’s able to cut, paste and modify genes • S/he tests in laboratories how medicines work	S/he wears a white coat and works in laboratories S/he knows a lot about diseases but does not work with patients S/he works with bacteria and mice
Environmental Biologist	• S/he knows what animals and plants live in the ecosystem • S/he knows the relationship between all elements of an ecosystem	S/he wears boots and a water bottle S/he loves the countryside where you only see plants, S/he’s able to distinguish all the living species
Doctor	• S/he knows the causes of diseases. • S/he knows treatments to heal diseases or reduce their symptoms.	Wears white gown. Works in a hospital. Understands x-ray radiographs and blood analysis.
Architect	• S/he is able to plan any kind of building construction. • S/he knows how to organize a city.	S/he feels at home among floor plans, pencils, models and computers. Never forgets a helmet to oversee constructions.
Industrial engineer	• Knows all the pieces on any engine. • If there is a problem, s/he will design a machine or vehicle that will solve it. • Fix machines and vehicles.	With a pencil, a ruler and a calculator s/he can design any machine or vehicle imaginable. In addition, in the mechanical workshops s/he feels happy, building what s/he imagined on paper.
Agronomist	• Design and build farms, greenhouses and fish farms. • Designs and manages land and farms.	Where you only see forest, s/he gets forest resources. Helps farmers to achieve maximum yield.
Mathematician	• S/he knows how to calculate. • S/he models systems and discover how they would work better • S/he uses math to encrypt codes	S/he likes mathematical theories and models S/he has a logical mind
Physicist	• S/he understands the laws that dominate nature	

	● S/he studies experimentally matter and energy ● S/he can predict natural phenomena using physical laws ● S/he designs technological devices	
Chemist	● Design and synthesize drugs. ● It can convert some molecules into others. ● Can synthesize new materials	The laboratory is his/her natural habitat. From chemical reactions s/he can get new drugs, new materials, fuel or electricity.
Geologist	● Knows what the subsoil is made of and how it behaves. ● Can find natural resources like coal or oil.	Understands the nature of volcanoes, can predict earthquakes and even know how to find holes in the subsoil.
Informatics programmer	● S/he understands how language and logics work. ● S/he is able to discover false arguments.	S/he understands computer language. Is able to design computer games, operative systems and apps.

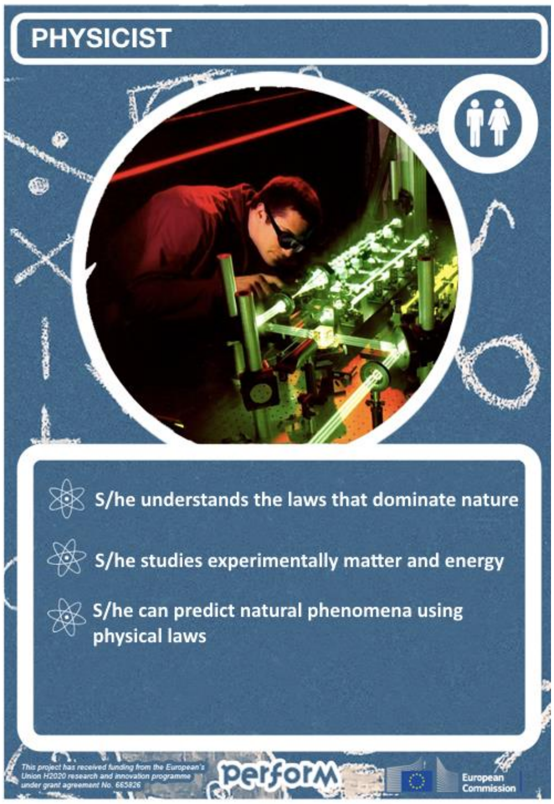
Places	Bullets	Brief Description
Laboratory	● Place full of advanced technology such as microscopes, sequencers, electrophoresis devices, etc. to work with DNA, cells and living organisms. ● Its equipped with instruments to carry out transformations of chemical molecules	DNA study and modification. Work with bacteria. Discovery, development and modification of medicaments Development of chemical reactions.
Crop field	● Outdoor space for growing experimental vegetables. ● May contain greenhouses. ● Can be used to test agricultural machinery	The vegetables produced can be used as food, medicines or biofuels, among others
Hospital	● Place to experiment with human patients. ● It has beds, operating rooms and equipment for the treatment of sick people.	Machines, drugs, and experimental treatments in humans are tested and monitored.
Informatics room	● Place where hundreds of computers are connected in series ● Here many processors work with millions of data in very few	Data storage and analysis. Mathematical calculations. Statistical analysis. Future prospects.

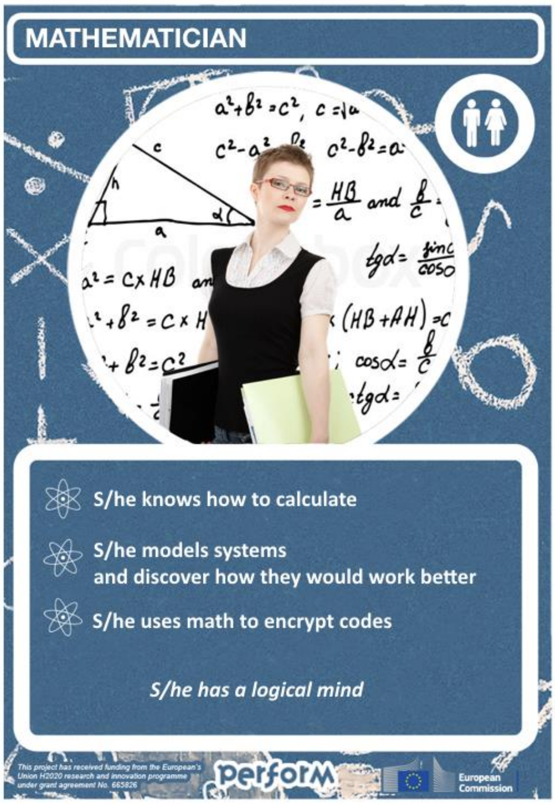
	seconds.	
Mechanical workshop	● Here many kinds of machines are assembled. ● Here engines, machines and robots are tested.	Machine assembly. Engines setting-up. Machine testing. Research with robots and assembly lines.
Natural environment	● Environment comprising living and inert beings in wild state, which means that has not undergone human modification.	Study of fauna and flora and their relationships. Minimize human damage and protect ecosystems
Office	● Room plenty of computers and desks. ● There are tools that help design ideas or floor plans. ● There might also be a coffee machine and microwave for lunch-breaks	Floor plans drawing and sketching. Models and prototypes design. Models assembly.

Projects: EU Societal challenges – some examples
Health, demographic change and wellbeing ● Genetic modification in human patients to cure diseases like diabetes. ● Generation of transgenic plants that produces drugs for malaria treatment.
Food security, sustainable agriculture, marine and forestry and the Bioeconomy ● Increase of plant food production through the use of specific farm equipment and greenhouses. ● Subaquatic farms: Salmon production in fish farms.
Secure, clean and efficient energy ● Windows as electric generators: generation of transparent solar panels . ● Renewable energy: bacteria that convert organic waste into electricity.
Smart, green and integrated transport: ● Design of a big city global transport plan. ● Development of electric cars.
Climate action, environment, resource efficiency and raw materials ● Recovery of endangered species: The Iberian Lynx. ● Reduction of atmospheric $CO2$ by subsurface storage.
Europe in a changing world - inclusive, innovative and reflective societies ● Bringing new technologies and Social Networks to everyone to give voice to oppressed collectives. ● Development of computers for tetraplegic patients.
Secure societies - protecting freedom and security of Europe and its citizens ● Technology development for earthquake prediction. ● On-line security and personal data protection.

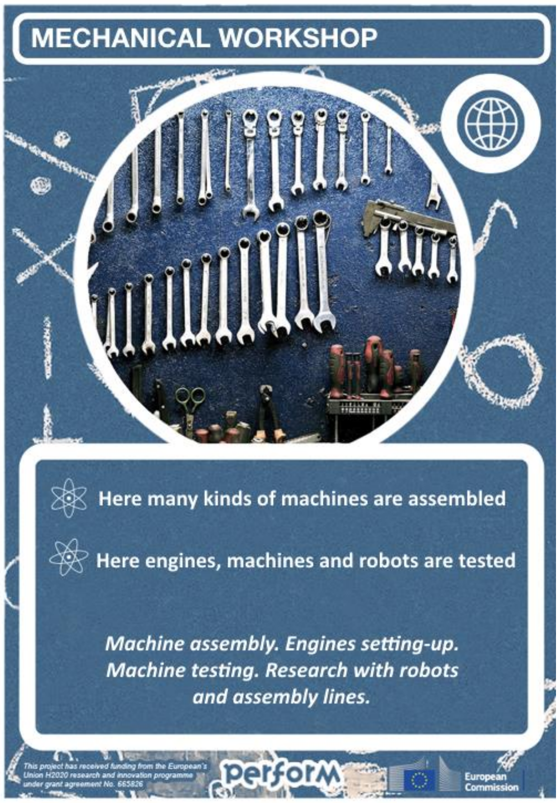
Examples of the Cards

<u>'Scientists' cards:</u>

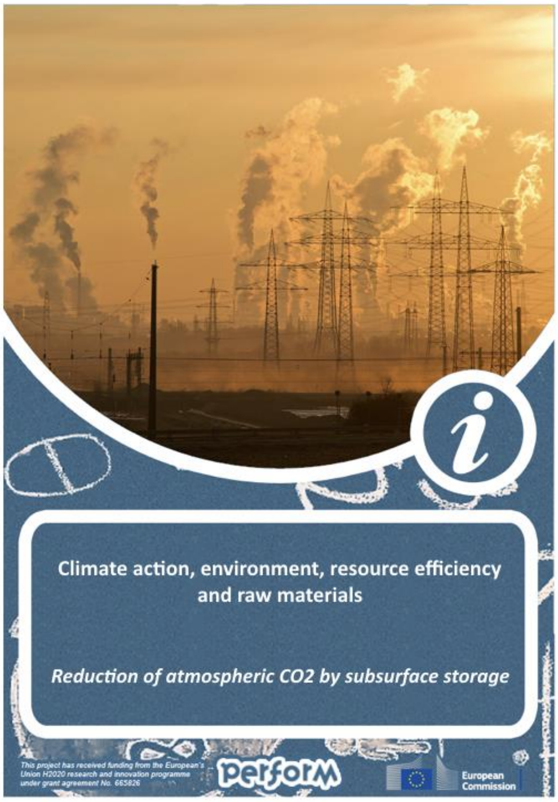




‘Places’ cards:



'Projects' cards:



Annex 2. Material for the PW "Art & Science"

Science images

Examples of images provided by the ERC, which represent their research field.

Nanotechnology and new materials, cosmology, drugs development, reforestation and climate change.

Art

Guernica, by Pablo Picasso (1937)

Annex 3. Material for the PW "Critical thinking and self-reflexion" (only in Spanish)

ESTACIÓN 1: LA FUENTE

¿Quién realiza la afirmación científica?

CROMOS REVISTA 100 AÑOS

Domingo 15 de Mayo de 2016

La Guanábana, la cura milagrosa del cáncer

¿Sabías que gracias a sus propiedades antioxidantes, nutrientes y vitaminas, esta fruta previene esta enfermedad?

La cura del cáncer

La doctora Gallego asegura que su efectividad en tratamientos contra el cáncer ya se ha probado en un estudio verídico y avalado por sociedades de medicina.
Gracias a sus nutrientes y alto contenido de agua, el consumo continuo y abundante de guanábana «evita que factores cancerígenos, como el envejecimiento celular, se desarrollen en el cuerpo».
http://cromos.elespectador.com/estilo-de-vida-salud-y-belleza/la-guanabana-la-cura-milagrosa-del-cancer-14823

ESTACIÓN 1: LA FUENTE

¿Quién realiza la afirmación científica?

Revista Cubana de Plantas Medicinales

versión On-line ISSN 1028-4796

Rev Cubana Plant Med v.15 n.3 Ciudad de la Habana jul.-sep. 2010

ARTÍCULO DE REVISIÓN

Valoración de la evidencia científica para recomendar *Annona muricata* L. (guanábana) como tratamiento o prevención del cáncer

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INTRODUCCIÓN: la divulgación en Internet de remedios "maravillosos", para curar enfermedades que son temidas por su posible desenlace fatal, o aquellos "curalotodo" capaces de solucionar un centenar o más problemas de salud son lamentablemente frecuentes y crean expectativas falsas en pacientes, familiares y hasta en profesionales de la salud. En la Web circula la información de que *Annona muricata* L. puede curar el cáncer.

CONCLUSIONES: no existe suficiente evidencia para recomendar el uso de ningún extracto o principio activo de *A. muricata* y la divulgación infundada de sus "extraordinarias propiedades anticancerígenas" es éticamente inaceptable.

http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1028-47962010000300009

ESTACIÓN 2: EL CONFLICTO DE INTERESES

¿Existe conflicto en quien realiza la afirmación científica?

By Victoria Ward 11:24AM BST 09 Oct 2015

The Telegraph

Coca-Cola gasta millones en investigación para demostrar que las bebidas azucaradas no engordan.

El gigante de las bebidas ha financiado a grupos de investigación los cuales han puesto en duda la relación entre las bebidas azucaradas y la obesidad.

Desde la sede de Coca-Cola en UK afirman: “Nosotros abrimos nuestra financiación a la investigación por parte de terceras partes. Nosotros creemos y confiamos en la investigación científica que se realiza sobre nuestros productos llevada a cabo por grupos independientes”.

Marion Road, profesora en nutrición, estudios alimentarios y salud pública en la Universidad de Nueva York ha dicho a la revista Times: “En mi opinión ningún científico debería aceptar financiación de Coca-Cola. Es totalmente comprometedor.”

ESTACIÓN 3: LAS EVIDENCIAS CIENTÍFICAS

¿Cuáles son las evidencias que validan la afirmación científica? ¿Son válidas las conclusiones extraídas?

Eficaz con pimienta

¿CÓMO ADELGAZAR 18 KG. SIN DIETAS? METODO NA MUSLOS DELGADOS I VIENTRE PLANO.

LOS CIENTÍFICOS LO CONFIRMAN: ESTE EXTRACTO BLOQUEA EL GEN DE LA OBESIDAD

¡Este descubrimiento de los investigadores de Seúl acaba con el sobrepeso en 40 días! De forma natural y sin efecto yo-yo Se acabó el gimnasio, se acabó el ayuno. La esencia de pimienta es suficiente para cambiar los michelines y la celulitis por una esculpida y esbelta silueta. Es un planteamiento completamente nuevo para la pérdida de peso y el tratamiento de la obesidad.

La ciencia aclara la eficacia de la piperina (producto de la pimienta)

Científicos de Corea han demostrado que la piperina acelera las reacciones del metabolismo en cadena. Los investigadores subrayan que su descubrimiento es una verdadera revolución en la pérdida de peso.

La toma frecuente de pimienta no es suficiente para obtener una figura bien formada. Afortunadamente, los suplementos salen a nuestro rescate. En el mercado español, han aparecido gran cantidad de preparados de piperina, pero sólo los suplementos con alto contenido de piperina adelgazan de forma eficaz. La mayor concentración de este componente se ha encontrado en **PIPERINE FORTE** (**clica aquí para comprar nuestro producto**)- hasta un 95% -

http://adelgazamiento365.com/

ESTACIÓN 3: LAS EVIDENCIAS CIENTÍFICAS

¿Cuáles son las evidencias que validan la afirmación científica? ¿Son válidas las conclusiones extraídas?

La pimienta negra no adelgaza.

¿Es la pimiento negra la nueva arma secreta contra la grasa? Una publicación reciente (puedes consultarla clicando aquí: paper) en la revista "*Journal of Agricultural and Food Chemistry*" por parte del grupo de investigación Coreano liderado por el doctor **Soo-Jong Um** dice que la *piperina*, un elemento presente en la pimienta negra, tiene la capacidad de hacer que el cuerpo NO genere nuevas células de grasa, y por lo tanto, puede ser utilizada en el tratamiento de la obesidad.

Pero este estudio ha sido realizado en células de ratones cultivadas "in-vitro". Es decir, el compuesto se ha probado en el laboratorio sobre células de ratón que han crecido fuera del animal. Es una práctica habitual en los laboratorios para reducir la experimentación con animales, pero los resultados que se obtienen son más limitados.

Además, para realizar este estudio se han utilizado concentraciones de piperina (el principio activo de la pimienta que supuestamente adelgaza) 100 veces mayores de las que podría soportar el cuerpo humano, con lo que los resultados no gozan de ningún tipo de aplicabilidad para las personas.

Así pues, el milagro de la piperina en la lucha contra la grasa se deberá mantener en el rango de "milagro", pues no existen evidencias científicas claras que lo corroboren en humanos.

http://www.npr.org/sections/thesalt/2012/05/12/152513462/black-pepper-may-give-you-a-kick-but-dont-count-it-for-weight-loss

ESTACIÓN 4: TRANSMISIÓN DE INFORMACIÓN

¿Pueden producirse errores en la cadena de transmisión de la información científica?

TITULAR DE UNA NOTICIA PUBLICADA POR LA CADENA "FOX NEWS":

El chocolate, una cura para la depresión, según un estudio

Published October 01, 2007

Fox News

ESTUDIO EN EL QUE SE BASA EL TITULAR ANTERIOR:

Efectos del chocolate en el estado de ánimo
By: Parker, G ; Parker, I; Brotchie, H
JOURNAL OF AFFECTIVE DISORDERS
Volume: 92 **Issue:** 2-3
Pages: 149-159
DOI: 10.1016/j.jad.2006.02.007
Published: JUN 2006

Resumen
Antecedentes: El consumo de chocolate se ha asociado durante mucho tiempo con el disfrute y el placer. Las reivindicaciones populares confieren al chocolate las propiedades de ser estimulante, relajante, eufórico, afrodisíaco, tónico y antidepresivo. La última afirmación estimuló este trabajo científico.

Resultados: El chocolate puede proporcionar su propia recompensa hedonista satisfaciendo los antojos, pero cuando se consume con una finalidad emocional, es más probable que se asocie con la prolongación de un estado de ánimo no eufórico en lugar de mejorar el humor.

Conclusiones: La mejora del humor por el consumo de chocolate es efímera.

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PREGUNTAS:

ESTACIÓN 1: Guanábana y Cáncer

- *¿Quién realiza la afirmación científica?*
- ¿Quién realiza la afirmación científica en cada noticia?
- ¿Es una sola persona, o son varias?
- ¿Dónde trabajan las personas que realizan la afirmación científica?
- ¿Es posible y fácil encontrar información de contacto de las personas que realizan la afirmación y de las instituciones donde trabajan?
- ¿Por qué creéis que alguien podría publicar una información científica ocultando su identidad?

ESTACIÓN 2 : Azúcar y Coca-Cola

- *¿Quien realiza la afirmación científica está en conflicto?*
- ¿Podemos creernos los resultados científicos obtenidos por grupos de investigación financiados por Coca-Cola?
- Maron Road dice, "ningún científico debería aceptar financiación de Coca-Cola."
- ¿Por qué creéis que los científicos pagados por Coca-Cola están comprometidos?
- ¿Por qué creéis que sus estudios podrían NO ser válidos?
- ¿Qué creéis que se podría hacer para que grupos de investigación puedan estudiar cosas como si la Coca-Cola engorda, sin verse comprometidos o influenciados por la empresa que paga esos estudios?

ESTACIÓN 3: Adelgazamiento Picante

- *¿Hay evidencias que demuestran la afirmación?*
- *¿Son válidas las conclusiones extraídas?*
- ¿La empresa que vende piperina presenta evidencias científicas claras acerca de los efectos adelgazantes de su producto?
- ¿Se dan facilidades para consultar el estudio científico citado (en qué revista científica se publicó, por qué grupo de investigación, quien lo publica)?
- ¿Los científicos que cuestionan la eficacia de la piperina presentan

evidencias científicas claras?

- ¿Dan facilidades para consultar el estudio citado?
- ¿Creéis que la conclusión de que la piperina adelgaza en humanos es correcta?
- ¿Por qué creéis que la conclusión de que la piperina adelgaza en humanos podría NO ser correcta?
- ¿Qué mecanismos utiliza la ciencia para asegurar que las conclusiones de los estudios científicos son correctas y válidas?

ESTACIÓN 4: El chocolate que cura

- ¿Existen errores en la transmisión de las informaciones científicas?
- ¿Cuál es la principal conclusión a la que llega el estudio "Efectos del chocolate en el estado de ánimo"?
- ¿El titular de las noticias de la Fox representa correctamente los resultados obtenidos por el estudio?
- ¿Por qué creéis que el titular es incorrecto?
- ¿Se trata de un error a la hora de interpretar el estudio, o podría haber algún interés por parte de Fox News?
- ¿Qué hace "buena" o "correcta" una información científica?

Alertas para la capacidad crítica en informaciones científicas

1- La ciencia es una práctica realizada por toda una comunidad, y no tan solo por individuos:
   a. La ciencia es producida por universidades, centros de investigación y empresas, no por individuos independientes.
   b. En ciencia, quien realiza las afirmaciones científicas debe identificarse claramente, para permitir que otros grupos de científicos/as puedan contactar con quien hace los experimentos, discutir los resultados y reproducirlos/contrastarlos si fuese necesario.

2- Los estudios científicos se deben realizar libres de conflictos de intereses. Si quien hace la afirmación científica beneficia a quien le paga esos estudios, o está intentando venderte algo, desconfía.

3- Las afirmaciones científicas están respaldadas por experimentos que las validan. En ciencia, cuando se afirma algo, debe estar demostrado y contrastado. Si las afirmaciones científicas no vienen respaldadas por una experimentación, ya sea práctica o teórica, no es una afirmación científica, es una opinión.

4- Es importante poder consultar los estudios originales, para asegurarnos de que las conclusiones que se extraen de los estudios son correctas y están validadas por la comunidad científica.
   a. Un estudio en ratones no es aplicable a seres humanos.
   b. La información científica se publica en revistas “peer-reviewed”. Esto significa que científicos expertos en el tema, pero independientes, han validado la información que se quiere publicar y han corroborado que los experimentos se han realizado correctamente y las conclusiones extraídas son correctas.

5- Los medios de comunicación pueden equivocarse a la hora de expresar los resultados publicados por la comunidad científica. Si vamos a contar hechos científicos (por ejemplo, en un monólogo científico) es importante estar muy seguros de la fiabilidad de la información e intentar consultar los estudios originales.

GUIA PARA LA BÚSQUEDA DE INFORMACIÓN EN INTERNET

- ¿Cuáles son las fuentes consultadas?
- ¿Quién realiza las afirmaciones científicas encontradas?
- ¿Hay evidencias/estudios/experimentos que validan las afirmaciones encontradas?
- ¿Quienes realizan las afirmaciones o los estudios están libres de conflicto?
- ¿Hay correlación entre las afirmaciones consultadas y los estudios originales?

FUENTES CONSULTABLES POR INTERNET Y SU CREDIBILIDAD CIENTÍFICA

¿Podemos creer en la ciencia? (worksheet)

¿Están los investigadores y/o las instituciones que realizan la investigación libres de conflicto de

No

Sí

¿Quién publica la noticia? ¿Una sola persona, o un equipo de investigación? ¿Es fácil saber dónde

No

Sí

¿El titular o la noticia reproducen correctamente lo expuesto en el estudio científico?

No

Sí

¿Las afirmaciones científicas presentadas están respaldadas por experimentos científicos?

No

Sí

¿Las conclusiones que se extraen de los resultados científicos son fiables, o están manipuladas para

No

Sí

Annex 4. Material for the activity "Research a researcher"

Research a researcher cards

These given as cards to each student, to record information presented by ECRs. A PowerPoint slide of information supplements the content on the cards, to invite students to make notes relating to RRI values.

My researcher's name:	

Write down what your researcher tells you about themselves so you can present them to the whole group

The person: What kind of person are they? Where do they come from? What is important to them?	
The science:	
The scene: Where does the research happen, e.g. the country, town, building, room; what equipment is used?	
The reason: Why does the World need this kind of research?	