Policy Brief

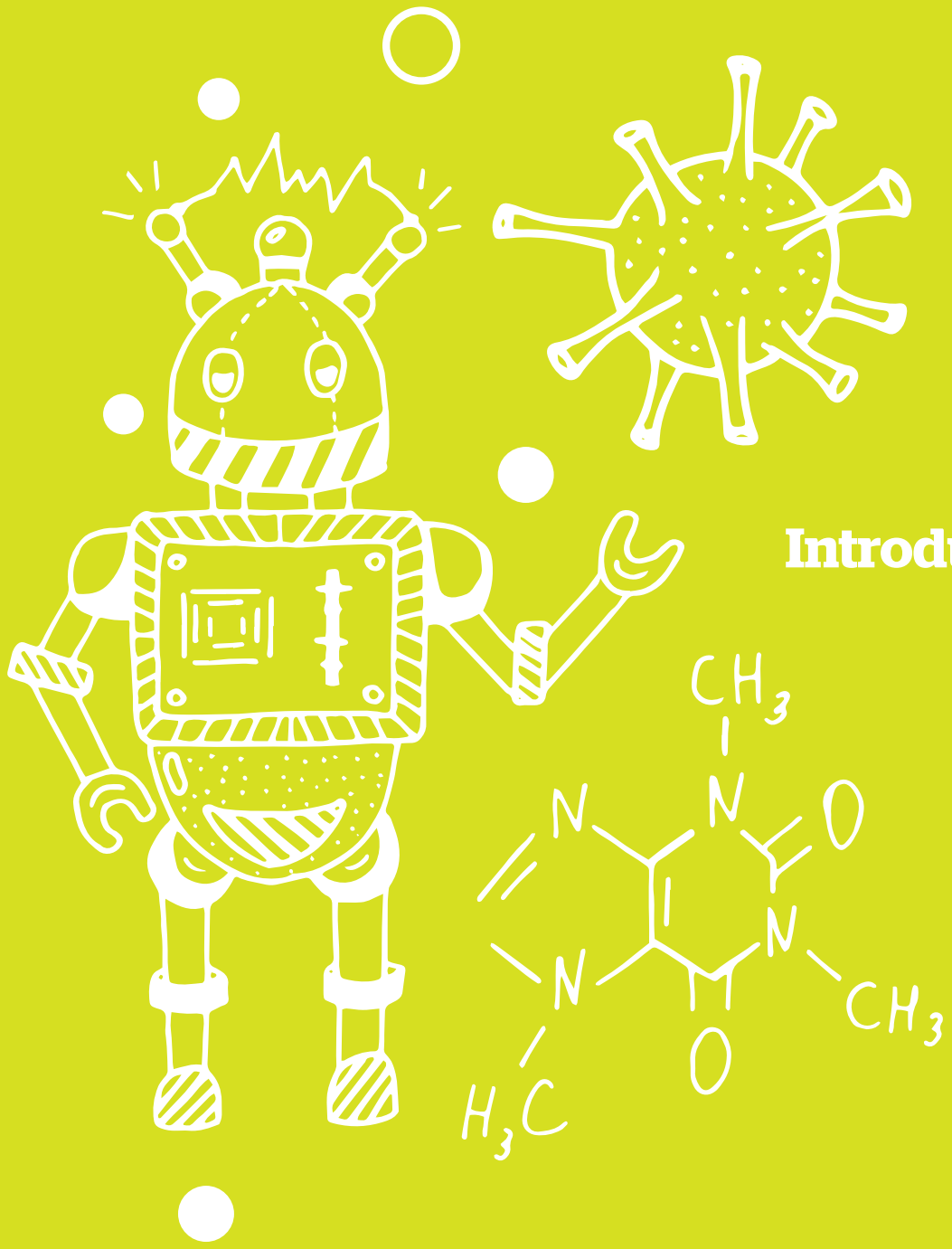
#3

Participatory Engagement with Scientific and Technological Research through Performance

perform

Encouraging students' engagement in science education through arts-based approaches

Policy implications of PERFORM, an EU research project exploring the impacts of arts-based science education approaches in secondary school students.



Introduction

Setting the scene

The European Commission's framework for Responsible Research and Innovation (RRI) seeks to align research and innovation with broader social values, emphasising the importance of public engagement, gender equality, education, ethics and transparency in research. The RRI approach highlights the need to overcome still persistent challenges in the dialogue of science with society. Such challenges apply specially to young people, and particularly girls, whose disenchantment with science hinders their scientific literacy and engagement with science-related careers. Among the reasons affecting young people's discouragement with science, previous research has identified the failure of traditional and mainstream approaches to science education and communication in inspiring and motivating young people, the influence of negative and pervasive stereotypes about scientists, and the lack of attention of science education curricula to transversal skills.

Within this context, the **PERFORM** project (2015-2018) responded to the EC call for **boosting the interest of young people in science and raising the attractiveness of STEM** (Science, Technology, Engineering and Mathematics) careers. PERFORM approached this challenge by investigating the effects of the use of **participatory science education methods** based on **performing arts** and the integration of **RRI values** in fostering secondary school students' motivations and engagement with science and STEM subjects. Research was conducted in 12 secondary schools in three case studies: **Paris** (France), **Barcelona** (Spain), and **Bristol** (UK), involving students aged between 13 and 17 years old. In each case study, PERFORM science communicators and artists applied different performing practices (improvisational theatre, stand-up comedy, and science busking) to involve students in an inquiry learning process that resulted in a performance put on by the students in which they explored scientific issues of their interest. Key in this process was the direct involvement of early career researchers, who shared their research experiences with the students and guided them in critical reflections about science as a practice and the role of science in society.

Science education and communication need to take action in order to challenge the remaining distance between young people and science and the mainstream formal education approaches in secondary schools. Evidence from the PERFORM project points to the **potential of arts-based approaches** in addressing the human dimension of scientific inquiry and emphasising **positive experiential aspects of learning** that can create new rapports of students with science. It also points to different design and implementation challenges and identifies educational and research **policy recommendations** to address them.

Evidence and analysis

How can we integrate RRI values into an inquiry-based science education approach by applying performing arts?

PERFORM put initial research efforts in the design of **arts-based science education activities** into which different **RRI values** could be embedded. PERFORM's educational approach mainly highlighted three RRI values: **inclusiveness** by ensuring participants' engagement, **ethics integration** through the incorporation of the human dimension of science, and **critical thinking** by including reflective questions and activities.

Following common guidelines stemming from these RRI-inspired principles, a set of participatory workshops were designed applying a specific artistic approach and implemented in each case study to fit local schooling contexts and participants' needs (see Diagram). PERFORM implemented these workshops at participating schools in two rounds in 2017 and 2018.

1

Inclusiveness:
enhancing students' active involvement in the activity and reaching diverse students' profiles and learning styles

2

Ethics integration:
reflecting about ethical aspects of science and research and connecting to relevant broader social contexts

3

Critical thinking:
students' ability to actively and creatively conceptualise, analyse, apply and evaluate information and knowledge.

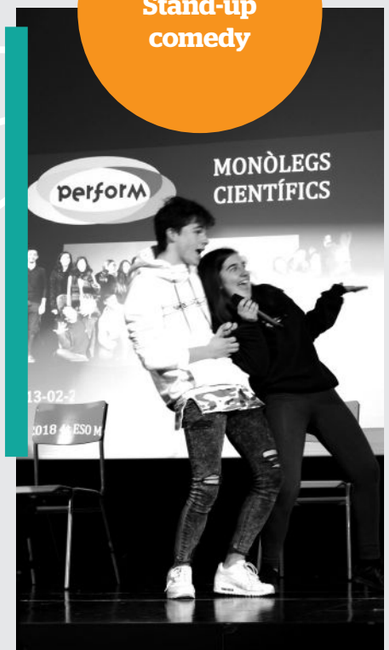
Improvisational Theatre

Improvisational Theatre: was used in Paris schools. During 7 workshops, students developed theatre improvisations based on scientific contents related to ECRs research, directed by PERFORM theatre actresses and directors. The workshops combined collective warm-ups, with improvisational exercises and the creation and rehearsal of short scenes. Around 10 students per group worked together with the support of a science communicator, an early career researcher and an artist who directed the workshops and created a final performance in which the students were the actors.

Science Busking

Science Busking: was used in Bristol schools. Throughout four workshops, students developed short sketches using demonstrative props combined with humour, theatre, music, and magic to inform passers-by about scientific topics that were principally based on the research area of a mentoring young scientist. PERFORM busking performers and experts in public engagement facilitated these workshops that were often split between reflective activities and busk-developing sessions, both involving a strong contact between students and the early career researchers.

Stand-up comedy



Stand-up comedy: was implemented in Barcelona schools. Students collectively created short monologues in which they combined story-telling, theatrical sketches and humor to explain scientific contents to an audience. This was done through six workshops that combined a first reflective activity on the nature of science with a second hands-on activity in which students worked on their scientific monologues with the support of an early career researcher, bringing to the creative work the reflections and contents generated before. Students worked at home on the development of their script, which they improved and rehearsed with the PERFORM science communicators at schools.

What elements were salient in fostering an engaging learning environment?

Evaluation data collected across the three case studies during and after the workshops highlight **three key methodological elements** of PERFORM's pedagogical approach, which have proven successful in creating an RRI-inspired design in science education:

1. THE MERGING OF ARTS AND SCIENCE: Discovering a new universe through playfulness

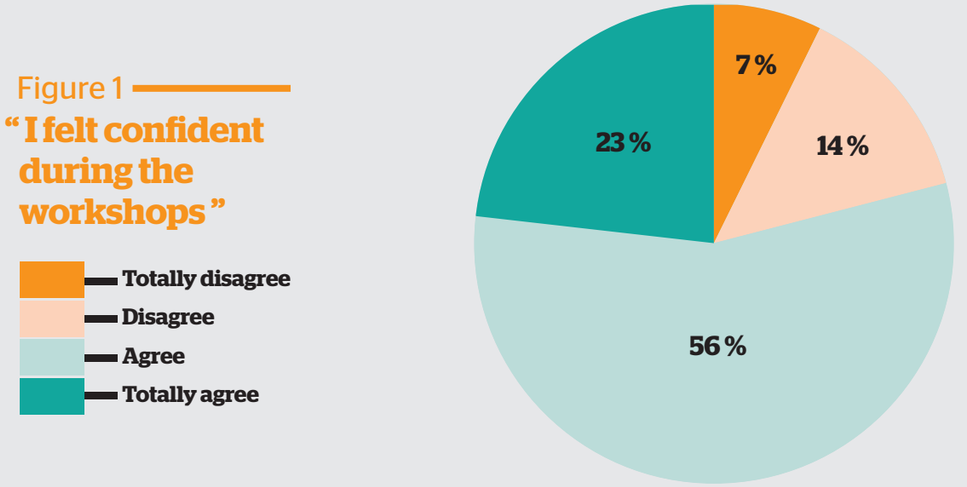
Learning scientific content at school through an **original approach** involving scenic arts and humour drew students' attention towards science. Through the games and theatrical exercises proposed, our team of science communicators created a **relaxed and supportive** learning atmosphere and a sense of connection with pupils. Students in the three case studies perceived this **playful environment** not only as motivating to get involved, but also as an invitation to do so without feeling judged; that is, to freely explore and play. Students in Paris and Barcelona especially appreciated the use of oral communication and the body when teaching and learning about science (instead of principally reading and writing in class). They also acknowledged that **working together** with science communicators and researchers in such a unique way allowed them to discover a 'new universe' of science and generated a sense of cooperation and trust. This facilitated spaces of exchange that minimized competition and fostered a sense of belonging. Indeed, as survey results show (see Figure 1), almost 80% of the students felt confident during the workshops.

2. STUDENT FOCUSED: Ensuring an active, inclusive approach

The combination of **diverse types of activities** within the workshops – such as collective warm-ups, small group performative activities, and plenary discussions – facilitated different student profiles feeling included in the educational process. This was achieved by engaging with a larger portion of students' personalities and learning styles, including those more animated and confident, as well as those more reserved and quiet, and pupils with different degrees of interest towards science. PERFORM science communicators **asked students to actively contribute** to these activities instead of 'just listening and copying', as they admitted to often doing in science class. As a result, most of the students felt they actively participated in workshop activities (Figure 2). Also, and to varying extents in each case study, with the support of science communicators and researchers students could choose the topic of their performances (often related to the researchers' field of expertise), the research questions, and the roles to play. Such **guided choice** was highly appreciated by both pupils and teachers across schools and was identified as an element increasing students' willingness to learn and get involved in the activities.

Figure 1

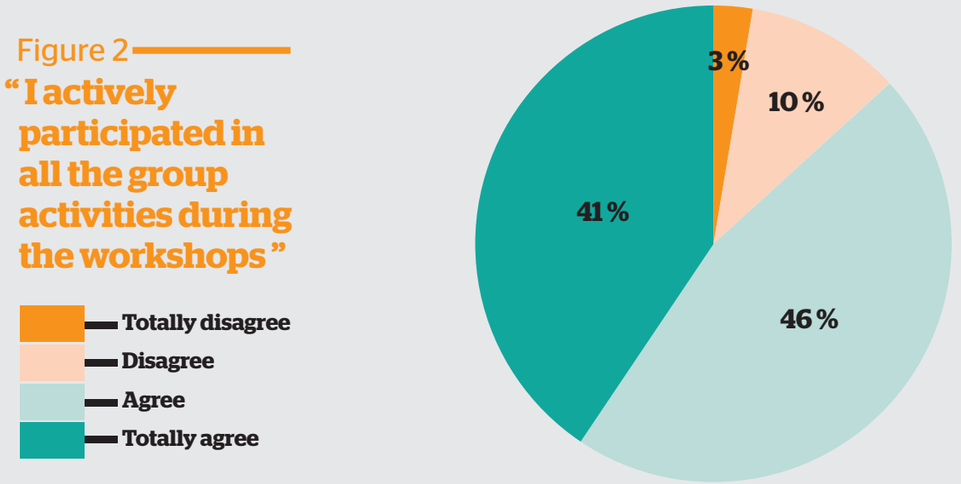
"I felt confident during the workshops"



Aggregated data from Paris, Barcelona and Bristol; second implementation round only (n=95)

Figure 2

"I actively participated in all the group activities during the workshops"



Aggregated data from Paris, Barcelona and Bristol; second implementation round only (n=94)

3. INTERACTION WITH RESEARCHERS: Making science real and connected to society

Science issues were consistently presented in the workshops in regards to their "impact on the world", which allowed for the **contextualisation of learning** and the sharing of **science as a practice** involving ethical values. Based on training in responsible communication and RRI delivered by PERFORM, early career researchers presented their research to students as connected to **real world issues** and emphasised how it could be applied for addressing societal challenges. They also encouraged students to critically reflect and collectively discuss ethical issues related to their research. Particularly in the case of Bristol and Barcelona, such discussions were further reinforced by specific **reflective activities** connecting STEM topics with controversial **ethical issues**. In Bristol, three guiding questions were used to prompt discussion and dig deeper in students' busks: *"What is the research trying to solve, Where might it take us in the future, and What might be controversial about it?"*

" What I liked about the sessions is that it felt like a very safe space, the kids could say just what they wanted. Without fear of any kind of negativity from any other kids. Something about it felt like... everyone else in the room was respecting everyone's opinion. Something you don't always get in a classroom "

Teacher interview,
Bristol Free School, Bristol

" The ethics training workshops is the thing I would highlight the most for me. I didn't know this existed (...). Questioning yourself what implications your research has in society was something new to me. It's so obvious now... but I guess if this project happens, it's because that's our need in our society. "

Early career
researcher, Bristol

The design and implementation of PERFORM's approach also entailed several **challenges** from which the project's research teams learnt:

- The **ambitious roadmap** traced by the RRI framework implied in practice a careful attention to the design of the educational activities so as to include the RRI-related values, while also expecting a diversity of learning outcomes. These requirements were sometimes incompatible with school functioning and the project time frames, creating certain constraints for PERFORM science communicators, such as the short time available for workshop sessions or a high number of students in workshops.
- Approaching science communication from the lenses of responsibility and research integrity also required a set of **skills and background** from researchers that was not always ensured, even with the contribution of PERFORM training.
- The willingness to involve **different participants** in the design and implementation of workshops in each school – such as the science communicators, artists, researchers, and teachers – often required a negotiation of goals and activities that sometimes affected the degree of engagement of some of these actors and consequently their contribution to the process and final performances. This affected, for instance, the balance between the artistic and the scientific dimensions of the project. Teachers' busy schedules or researchers' pressure from their institutions to focus on academic work were also factors affecting their availability and involvement in the project.

These are all aspects that should be taken into account while developing similar projects in order to put in place institutional mechanisms that facilitate participation beyond individual willingness, avoid setting expectations that will not be met and focus on feasible, yet meaningful, goals.

What is the added value of integrating artistic methods into an inquiry-based learning approach?

In this section, we address how these different elements might have contributed to enhancing secondary school students' interest and motivations towards science, through three dimensions of analysis: **contributions to transversal competences** related to science learning, contributions to **students' perceptions** of science and contributions to raise **scientific vocations**.

1. Contribution of the workshops towards improving transversal competences

Data collected during the evaluation from workshop participants through surveys, interviews, focus groups and observations suggest that, globally, the groups were quite diverse and PERFORM's approach allowed students to **work from their own level** of skill and knowledge. Our analysis of these data identifies **four main contributions** of PERFORM's approach to students' transversal competences:

> COLLABORATIVE AND SOCIAL SKILLS: Facilitating spaces for cooperation and dialogue

The collaborative nature of the project was a way for students to develop teamwork skills. In the three case studies, students, researchers, and teachers appreciated the work in small groups towards a common outcome, with students equally sharing tasks and roles according to their own motivations and capabilities. Reflecting this, 86% of the surveyed students agreed that they fairly shared the tasks throughout the workshops (Figure 3), with girls being significantly more in agreement ($p<0.05$). This was achieved, partially, by fostering students' respect towards different opinions and perspectives during discussions and group work for the creation of the resultant performances, and the establishment of relationships of trust.

> COMMUNICATION SKILLS: Providing new expressive resources and tools to students

Closely linked to collaborative and social skills, the artistic elements of the approach clearly managed to put in practice and unfold students' ability to communicate. As they themselves recognised in the survey, 75% of the students considered that the workshops and performances helped them improve their communication skills (Figure 4). Interviewed students and teachers revealed that such skills referred to: i) communication among students (e.g. listening skills), ii) communication with the researchers and science communicators (e.g. capacity to express ideas, emotions and opinions) and iii) communication with an audience (e.g. capacity to express themselves in front of an audience and overcoming shyness). The embodied and artistic elements of the approach seemed to particularly support students with new or different expressive resources such as creating a narrative thread out of scientific information or capturing an audience's attention, which can be further applied within and outside of school contexts.

> SENSE OF INITIATIVE: Fostering self-confidence through performance

When properly accompanied and supported by the science communicators, the performances provided a platform for students to enhance their self-confidence and self-esteem. Indeed, many students faced 'stage fright' when performing their scientific busks, monologues, and theatrical sketches in front of an audience. Rehearsals were key to overcoming such fears, together with the progression of theatrical and communication exercises throughout the workshops. Also, the goal of achieving a common outcome seemed to infuse a sense of responsibility and initiative among students, nurturing learning skills that can be transferred to any other learning or life context.

> LEARNING TO LEARN: From inquiry skills to critical thinking

The different emphasis of PERFORM communicators in reflective thinking and scientific inquiry during the creative process, together with the diversity of students' academic backgrounds across schools led to a differentiated development of learning to learn skills. In Paris, reasoning and argumentation were mostly oriented towards the theatrical *mise en scène*, while the scientific content was generally not critically approached. In Barcelona, science communicators and researchers encouraged students to put into practice their inquiry skills to create monologues by identifying research questions, searching for information in valid sources, and critically assessing their evidence. In Bristol, students' critical thinking was further encouraged through the reflective guiding questions provided by the researchers, which facilitated open discussions about complex subjects. Figure 5 shows how students' perceptions of their own ability to formulate research questions significantly increased after the workshops *($p<0.05$)*, and particularly among girls *($p<0.05$)*.

" Teacher: I was really surprised because there were kids that since the beginning said they wouldn't do the monologue, they wouldn't perform. But then, it was precisely these students who went up onto the stage and really stood out. And I am so proud of them, because some did really overcome their shyness. I feel especially happy about those pupils.

Researcher: They were girls?

Teacher: Yes, all of them "

Teacher interview, Broggi School, Barcelona

“ I learnt that it is better to be in a team and help each other than be alone with no one to help me [...]. I could do more with a team than me alone, that is what I learned.”

Student survey,
Bridge Learning
Campus, Bristol

“ I learnt how to improve communicating and expressing my voice.”

Student survey,
Bridge Learning
Campus, Bristol

“ For the oral presentations of our internships, communication could help us because there are some reserved people in our class, who did not like communicating too much with other people or they were shy... so I think it opens doors [for them].”

Student focus group,
Villiers School, Paris

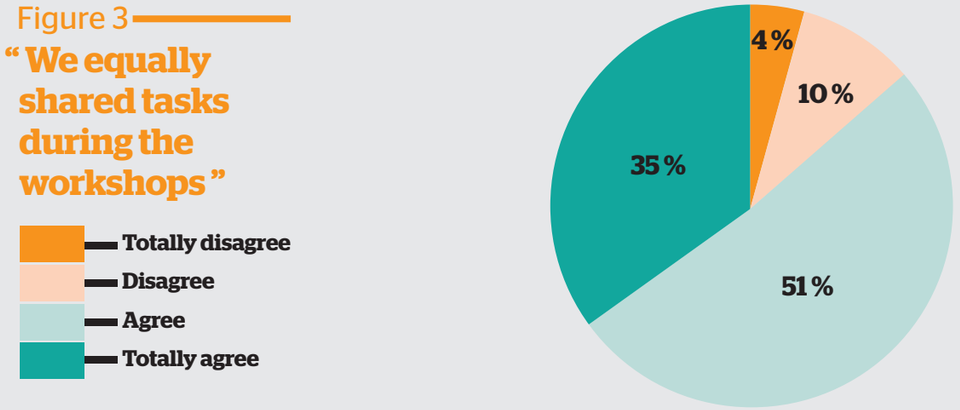
“Researcher: What do you think is PERFORM’s added value?

Teacher: It shows a different way of collecting information, of being critical with the information we use and is in our reach. All this process of looking for information, validating it, using it... it is really very useful and it makes (the pupils) reflect a lot (...). I think this really worked well.”

Teacher interview,
Broggi School, Barcelona

Figure 3

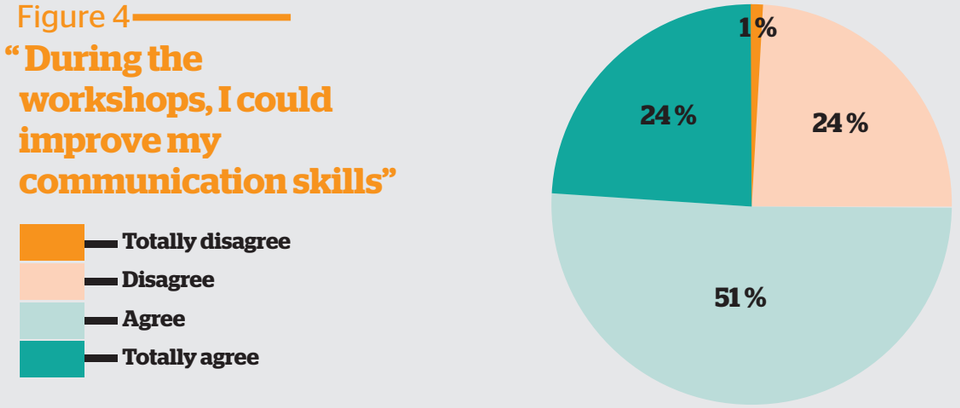
“ We equally shared tasks during the workshops ”



Aggregated data from Paris, Barcelona and Bristol; first and second implementation round (n=189)

Figure 4

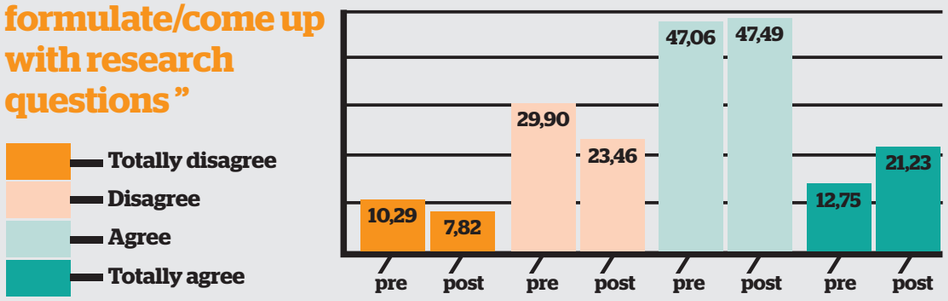
“ During the workshops, I could improve my communication skills”



Aggregated data from Paris, Barcelona and Bristol; second implementation round only (n=96)

Figure 5

“ I am able to formulate/come up with research questions ”



Aggregated data from Paris, Barcelona and Bristol; first and second implementation round (n pre=204; n post=179)

2. Contribution of the workshops towards enriching students' perceptions of science

After the second round of workshops, **73% of students reported that the project helped them think differently about scientific issues** they previously thought to be right/true (Figure 6). Barcelona students agreed more with this statement, in contrast with those in Paris, who were equally divided between agreement and disagreement, while the Bristolians' perception was in-between (Figure 6).

When asked about what had specifically changed, students' answers revolved mostly around two themes: **improving their perceptions about science learning** by experiencing PERFORM's different way of learning and enlarging their **understanding of the nature of science** by discovering science as a practice. Regarding the latter, students, teachers, and researchers identified such enlargement with:

> **Thinking more broadly about science: unveiling the diversity of topics, disciplines and applications in science.** Many students identified a much broader field of topics within science after the workshops, realising that science is more than just 'clearly defined categories in a textbook' and that it can be practised outside a lab (by getting to know real-world applications of different disciplines). For instance, in the three Bristolian schools, students expressed the realisation that "everything is science", which was echoed in Paris and Barcelona as well. Also, Bristolian and Barcelonian students expressed discovering new scientific branches related to the participant researchers and different career pathways in science.

" And then in the project, you find young specialists, very open-minded, who know how to explain things well and even better, with sense of humour and gracefully and of course... your view changes (...). If society is showing you all the time a scientist isolated in his house, very competitive, most of the time a man, because we rarely see women, well... Coming here just blows your mind, with such a variety of scientists and at the same time all so human... "

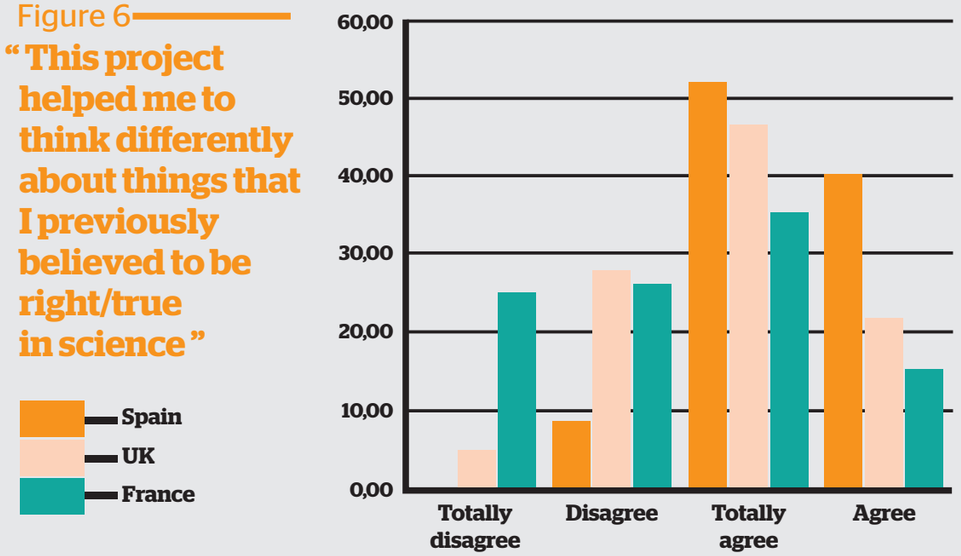
Student focus group, Consell de Cent School, Barcelona

"In our school, girls showed a lot of interest but some of them thought they were not good enough to be like you. So we helped them a lot in that sense. Like for instance when they asked us: how did you get there? (...) I think that was our contribution: make them see they could achieve it too. "

Early Career Researchers focus group, Barcelona

Figure 6

" This project helped me to think differently about things that I previously believed to be right/true in science "



Data per case study, second implementation round only (n=92)

" In the workshops I can remember certainly some students being really engrossed by what the researchers were doing, asking really good questions, 'how is this useful, why do you do this,' and I think it made the science kind of real for them. So yes, they learn it in the classroom but [in the workshops] they can see how it's used, and how it's applicable. "

Teacher Interview, Castle School, Bristol

" Today thanks to Valentina [their group ECR], there you go: science is going a lot better [for me]. In earlier years of secondary school, when I looked at my school notebook, I just closed it again. While here I can get a bit more interested in science than before! I see Valentina doing her job... "

Student focus group, Villiers School, Parisl

> **Discovering science as a practice: making scientific research real.** Across case studies many students reported an increased knowledge about the job of a scientist, and in Bristol and Barcelona also about the social implications of research. The interdisciplinarity and duration of research, the importance of teamwork, the possibility of failure and the role of creativity within science, represent different characteristics highlighted by students, teachers, and researchers as being transmitted through PERFORM, which also contributed to fostering a more humble and human view of science.

Particularly, the **presence and interaction of the researchers** within a creative learning environment had a positive impact on students' perceptions of scientists and, in some cases, on their relationship with science (for instance, identifying more with science). In Barcelona and Bristol where such a presence was more salient, researchers offered a different role model that helped deconstruct students' stereotyped images of scientists in terms of:

> **Scientists' personality:** showing that scientists can also be warm, close, and funny people.

> **Scientists' skills:** by portraying a humbler image of scientists ('scientists do not know everything', being 'super-brainy' is not a must) and emphasizing, instead, the relevance of passion, perseverance, and motivation for being a scientist.

> **Scientists' gender:** by bringing real female references for young girls at school to make more visible the presence of women in research. This was especially noticed in the case of Barcelona where most of the researchers were women, and girls in the workshops recognized their presence as being inspiring for them.

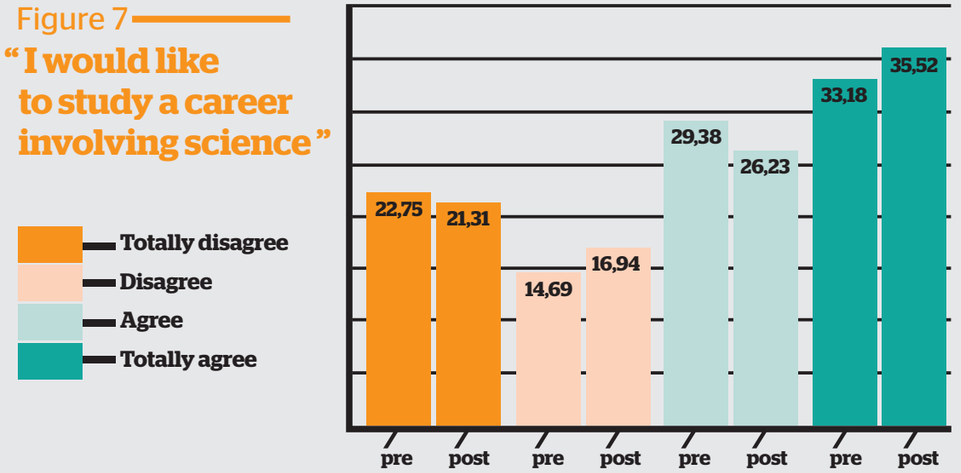
3. Contribution of the workshops towards enriching students' perceptions of science

All data sources across the three case studies indicate that students generally derived much **enjoyment** from the workshops. During the sessions, students were often attentive, smiling and laughing, particularly in more physically active activities such as performance creation. Similarly, students in focus groups almost universally expressed that they enjoyed the workshops. This is relevant as the project managed to engage in science learning students both interested and not interested in science. In Paris and Barcelona, teachers particularly highlighted the active involvement and excitement of students who in normal science classes were often disengaged. When asked about changes in their perceptions of science, many students connected their enjoyment of the sessions with **increasing their learning ability and interest in science**.

However, our data also show a differentiated impact of the PERFORM's approach in encouraging interest in scientific vocations; that is, in making the leap from enjoying science learning to then be willing to study science careers. **PERFORM seemed to reinforce the willingness of those students with an existing interest in science or a certain hesitation, but those who did not initially identify with science still did not consider it to be an option after.**

Figure 7

"I would like to study a career involving science"



Aggregated data from Paris, Barcelona and Bristol; first and second implementation round (n pre=211; n post= 183)

" In the workshops we worked with the researchers (...). We did science but differently, playing science actually. We didn't do it like we do in the classroom."

Student focus group, Montreuil School, Paris

" Thanks to the workshops, I've seen many more topics and they have captured my attention... I've seen that I like science, I enjoy it. I think (PERFORM) is a way of teaching that captures students' attention"

Student focus group, Consell de Cent School, Barcelona

" I see the passion [for science], it must be cool, but I do not see my life in it ... On the other hand, if I had learned science the way I learned this year I think I would have headed in that direction."

Student focus group, Villiers School, Paris

" I've seen that there is a lot of variety of (scientific) professions and that has helped me open my mind. It has also helped me decide about my studies, since (I can see that) if I'm eager and motivated about them, they will go better for me"

Student survey, Broggi School, Barcelona

Figure 7 shows the diversity of attitudes towards scientific careers reported by students. The percentage of students in strong agreement with studying STEM careers increased after the workshops, while those with strong disagreement decreased, but these differences were not statistically significant. Except for one school in Barcelona, in schools where more boys than girls were willing to study a scientific career, this was maintained after the workshops. This being said, some students in Barcelona reported that projects like PERFORM are helpful in their career choice for those willing to study science-related subjects, as they give them the opportunity to ask questions directly to scientists about scientific careers and listen to their personal experiences and motivations to study science, contributing to their ability to question stereotyped views of science.

This puts in evidence the **constellation of factors affecting students' career choices** beyond the enjoyment of science learning and particular perceptions of science, and calls for more holistic and integrated approaches with the potential to generate long-term interactions and positive experiences able to combine with other factors, such as family support or economic background. Also, students and teachers perceived that what pupils learnt in the workshops was not connected to what they learnt in science class. Such distinction between '*science (learnt) at school*' (focused on scientific facts and contents) and *'science (learnt) in the workshops*' (focused on the human and practical dimension of science) should be overcome in order to generate long-lasting learning experiences beyond occasional projects.

Policy implications & recommendations

The evidence collected during the three years of the PERFORM project points to the potential of the performing arts to address the human dimensions of scientific inquiry and to emphasise positive experiential aspects of learning. These aspects can create new rapports between students and science, and enhance their motivations and interests in learning about science subjects. In turn, PERFORM also demonstrates several challenges relating to the design and implementation of these approaches in school settings. Based on our analyses and learning through the project, we provide a set of **policy recommendations to facilitate and take full advantage of the implementation of arts-based science education approaches in secondary schools:**

1

Educational policies addressing science curriculum development should place more emphasis on the contextualization of science teaching and learning and the connection of scientific contents with relevant research, to provide a meaningful image of science and scientists to students

The direct interaction between researchers and students was one of the key features of the project, as it allowed a closer and more contextualised rapport with science. One mechanism to promote such contact is the establishment of direct interactions with research centres and researchers, to bring both scientists to schools and pupils to research settings. To facilitate such interactions and put students in contact with researchers, schools and research institutions could also take advantage of online resources and platforms, such as videos introducing individual researchers or social networks to exchange information. This would not only facilitate students' understanding of science as a practice, but would also help break students' stereotypes about scientists and their jobs, and bring science closer to their lives.

2

Educational policies related to educational planning in the secondary cycle should promote greater flexibility in the curriculum to encourage interdisciplinary project-based approaches in the learning of science.

PERFORM science communicators faced implementation constraints related to school functioning, such as the lack of time available – both students' and teachers' – for conducting activities using artistic methods out of the science curriculum. Having a greater flexibility in curriculum management for implementing project-based approaches similar to PERFORM would tackle some of these limitations and strengthen educational goals related to research. Moreover, together with the previous recommendation, this would help overcome the difference identified between "science experienced in PERFORM" and "science taught at school", potentially enhancing the long-term impacts of these experiences in students' learning, beyond an occasional project or workshop.

3

Educational policies regarding the training of secondary school teachers could benefit from the integration of performance skills and theatrical exercises oriented towards science learning.

Performance-based approaches have the potential to strengthen students' learning autonomy and help them be more focused when learning science at school. Providing teachers with resources to guide creative and physically active activities, such as interactive games or short sketches to approach science, can encourage them to integrate some of these approaches into their teaching of science, as expressed by teachers participating in PERFORM.

4

Institutional and research policies shaping research priorities and scientists' training should acknowledge the importance of public engagement and promote it through specific initiatives.

Researchers participating in PERFORM reported difficulties to reconcile their research work with public engagement activities. Policies should facilitate their early involvement into these kinds of activities as part of their regular academic duties. One mechanism to do so is to academically recognise the importance of public engagement in science and coherently promote it, such as by: i) acknowledging its relevance in research calls and applications, ii) providing time and financial resources to make possible researchers' active involvement, iii) facilitating researchers' access to trainings on and tools for public engagement; and iv) reinforcing the communication and collaboration of scientific research institutions with educational agents such as schools and teachers.

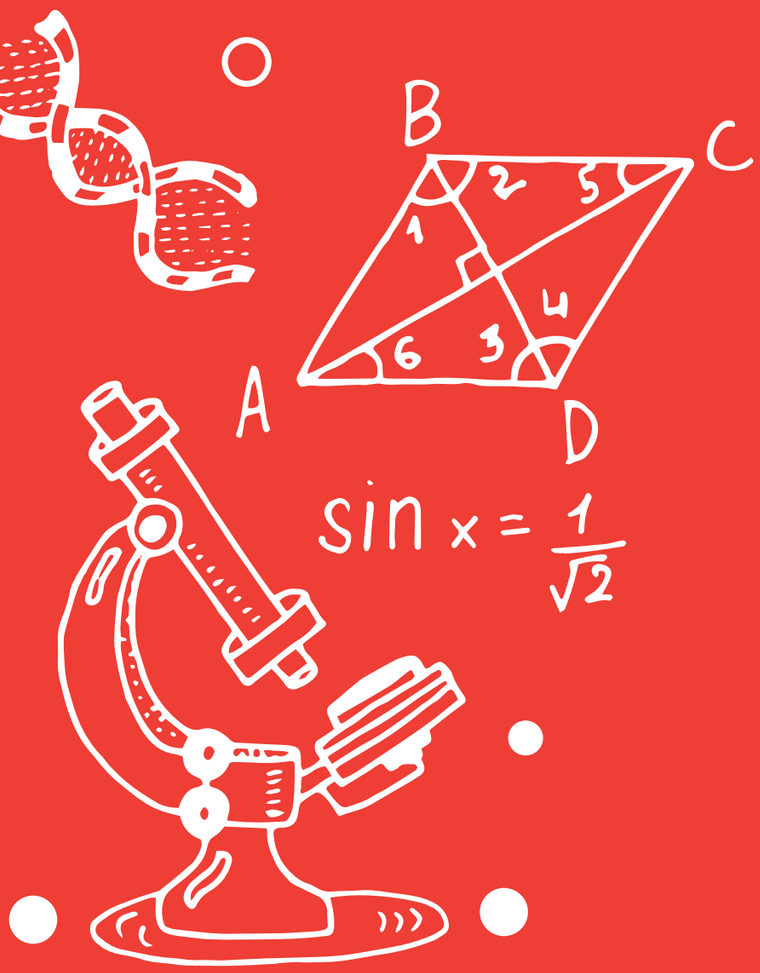
5

Institutional and research policies addressing trainings for early career researchers should incorporate and acknowledge the benefits of reflective thinking about science and research ethics.

Participant researchers highlighted the relevant contributions of the RRI training to their background and practice and the general lack of similar trainings during their PhD. They also recognized that more training is needed in order to interact with non-academic audiences, offering a critical yet responsible view of science. Researchers' trainings on science reflexivity and philosophy of science should be more broadly integrated within their educational background in order to improve researchers' skills in this regard and foster responsible science communication. This would support both researchers' better understanding and implementation of the principles of RRI, and a better communication with students and non-academic audiences while participating in dissemination activities.

These policies are synergic and therefore a parallel implementation would increase the possibilities to reach their full potential.

Research Parameters



Objectives

PERFORM (Participatory Engagement with Scientific and Technological Research through Performance; Nov 2015-Oct 2018) was a research project seeking to **investigate the effects of the use of participatory science education methods based on performing arts in fostering secondary school students' motivations and engagement with STEM** subjects. For that purpose, performance-based activities were developed and integrated into science education workshops aimed at: i) fostering secondary school students' engagement in science through direct interaction with early career researchers and science communicators in a creative environment, and ii) training students' transversal competences needed to pursue STEM careers, with a special emphasis on girls.

Methodology

The current policy brief is based on the assessment of the participatory educational process that was generated through the implementation of the workshops in 12 secondary schools in Paris (France), Barcelona (Spain) and Bristol (UK). Our assessment was focused on three main dimensions related to the objectives of the project:

- The integration of RRI values in the design of the educational approach (inclusiveness, engagement, and ethics integration)
- The impact of the workshops on students' transversal competences[1] related to reflective thinking skills, social and communication skills and sense of initiative
- The impact of the workshops on students' general perceptions and attitudes towards science, including students' scientific vocations

We implemented a **mixed methods research approach**, combining different qualitative and quantitative data collection methods, data sources, and analysis strategies (see Table 1).

We quantitatively approached students' perceptions and attitudes towards science and their self-perception of science-related competences, through a **written survey** delivered prior and after the workshops. We assessed whether there were statistically significant differences before and after the workshops, by gender, and between the PERFORM group and a control group[2].

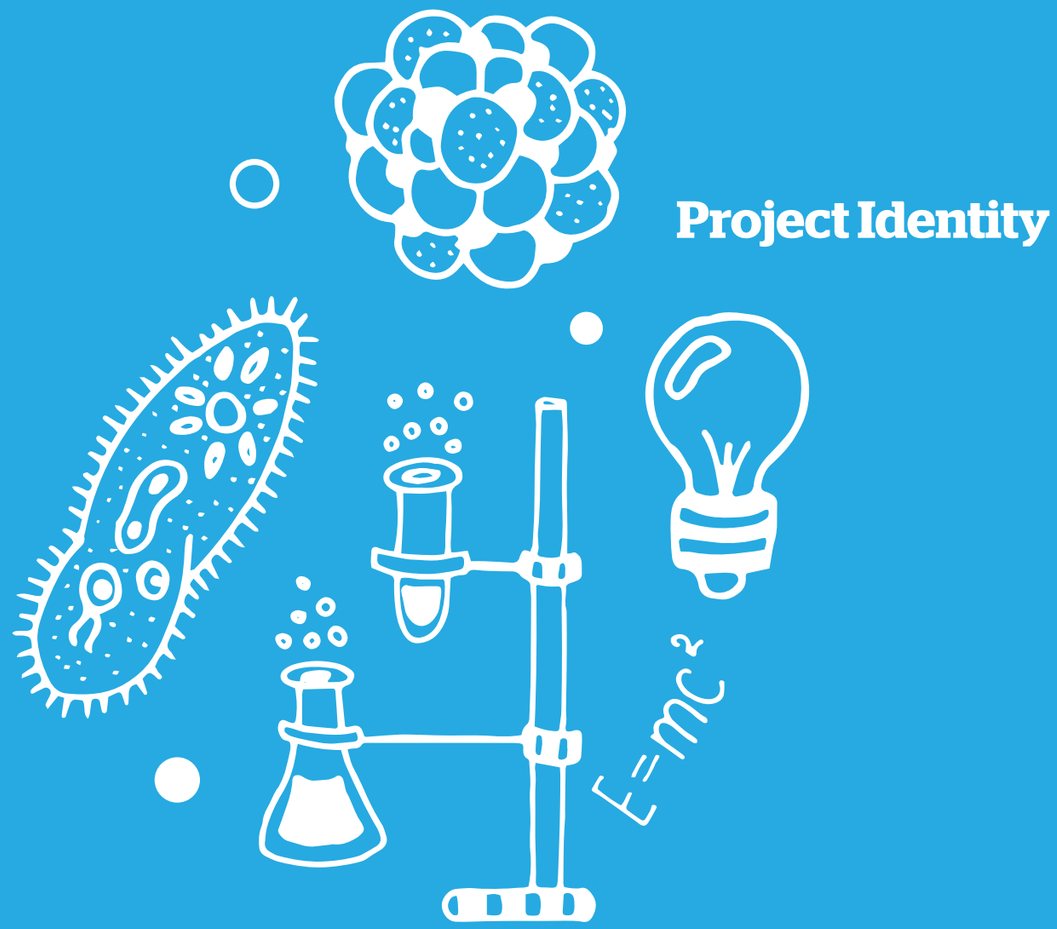
[1] Our aim was to characterise the process according to its capacity to foster transversal competences, and not to assess students' individual achievement.

[2] The items presented in this policy brief correspond to Likert scales ranging from 1 (totally disagree) to 4 (totally agree). We used the Wilcoxon Ranking Test for statistical analysis, level of significance $p<0.05$

We conducted qualitative data collection and analysis to get in-depth insights about the experiences and impacts of the project:

- Students' answers to the survey were further explored through **focus groups**, and **formative evaluation** activities were conducted with the students to reflect on their learning.
- Transcriptions of the **systematic observations** of the workshops were analysed to explore how the pedagogical approaches had integrated RRI values and fostered learning
- **Interviews** with involved teachers and early career researchers addressed their perceptions of PERFORM's approach and its impacts on students

Target	Focus of the assessment	Assessment methods		
		Before the workshops	During the workshops	After the workshops
Secondary school students	> Perceptions and attitudes towards science > Self-perceived transversal competences > Perceptions and experiences of the workshops	Written Survey (Barcelona, n= 110 Paris, n= 84 Bristol, n=60)	Systematic observation (All workshops) Formative evaluation (throughout the workshops, all pupils)	Written Survey (Barcelona, n= 96 Paris, n= 63 Bristol, n= 60) Focus Group (Barcelona, n= 32 (4) Paris, n= 28 (4) Bristol, n= 25(4))
Secondary school teachers	> Perceptions of the process and its impacts on students > Attitudes towards including these approaches in science education		Systematic observation (All workshops)	Group interview (Barcelona, n= 16 (4) Paris, n=10 (4) Bristol, n= 5 (3)) Individual online interviews (Barcelona, n= 1 Bristol, n=2)
Early career researchers	> Perceptions of the process and its impacts on students > Engagement in the workshops		Systematic observation (All workshops)	Group interviews (Barcelona, n= 8 (2) Paris, n= 4(2) Bristol, n= 11(2)) Individual online interviews (Barcelona, n= 8 Paris, n= 6)



Project Name: Participatory Engagement with Scientific and Technological Research through Performance (PERFORM)

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Science Made Simple –SMS, LTD – Cardiff, United Kingdom

Atelier de Jours à Venir – AJA, SARL – Paris, France

United Nations Educational, Scientific and Cultural Organization – UNESCO – UNESCO – Paris, France

Théories et Réflexions sur l'Apprendre, la Communication et l'Éducation Scientifiques – TRACES – Paris, France

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Further reading

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