Deliverable No. [D.3.2]

Toolkit for teachers wanting to develop PERSEIAs

Project acronym:
PERFORM

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

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SUMMARY

PERFORM brought teachers and students together with early career researchers and performers to develop performances, to encourage a more reflective understanding of science and its role in society. During 2016-2018, PERFORM delivered two rounds of bespoke training for teachers in Bristol, Paris and Barcelona to enable science teachers to develop the relevant cross disciplinary skills to use creative teaching methods involving performance and discussion.

This user-friendly toolkit presents key learning from PERFORM. It contains videos which introduce students to real science researchers from across Europe, as well as activity cards with instructions for quick, performance-based activities and discussions. It also contains guidance notes to support teachers to use the various resources to inspire students to become more informed, engaged citizens and to consider a career in science for themselves. It will be freely accessible online for secondary teachers across Europe.

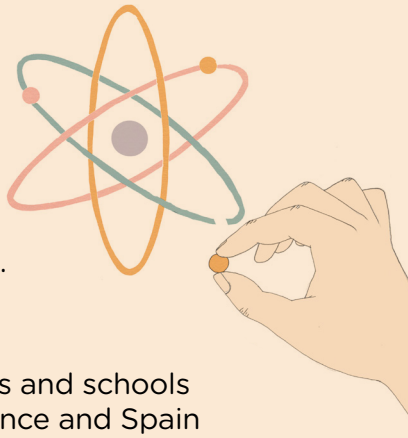
PERFORM toolkit: why should you use it?

This toolkit provides science teachers with a series of resources to help stimulate discussion on science and society in the classroom. Resources are most suitable for students aged 14-16.

Alongside the development of knowledge and understanding of the fundamental concepts of science, the English curriculum also proposes that students should gain an insight into 'working scientifically' and an appreciation of the relevance of science to their everyday lives (Department of Education, 2015). The Spanish curriculum further states that students should conceive scientific knowledge as integrated knowledge and should know how to critically evaluate the contribution of science and technology to our society (LOMCE, 2013). Further complimenting these statements, the French curriculum expresses that students should be prepared for responsible citizenship, especially in the areas of health and the environment by gaining an understanding of advances in technology and economics, in order to assume the appropriate social and ethical responsibilities as citizens (Ministère de l'Éducation nationale, 2015).

The activities and resources in this toolkit have been designed to help students develop a set of transferrable skills as well as a more reflective knowing of science in which they consider purposes, values and how science becomes reality.

This toolkit contains a collection of short *Meet the Scientist videos* which introduce students to real researchers in the early stages of their careers. An accompanying document suggests how teachers can use the videos to inspire students to consider a career in science for themselves. A set of *Performing Science Cards* offer instructions for a selection of quick, interactive performance-based activities and discussions, based on ethical questions. All the resources in this toolkit are designed to support learning on a wide range of scientific topics across the secondary science curriculum. *Practical guidance* is provided to help you make the best use of these resources and activities in your classroom.



This toolkit distils ideas and techniques used during teacher training sessions and schools workshops that were developed during the PERFORM project in the UK, France and Spain in 2015-2018.

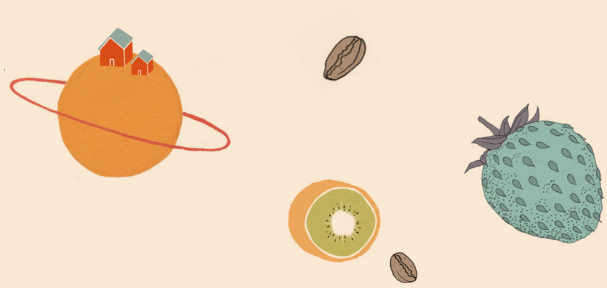
Enhance transferable skills

The performance and discussion-based activities in this toolkit will help students to develop key transferable skills, benefitting their engagement with science and also enhacing their learning in other curriculum areas. Crucially these activities will help students to become more informed citizens; able to critically engage with the natural world and an increasingly 'information-rich' and technological society.

Developing transferable skills compliments the 'working scientifically' element of the science curriculum in England, which expects students to:

- appreciate the power and limitations of science and consider any ethical issues which may arise.
- explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.
- evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences.
- recognise the importance of peer review of results and of communicating results to a range of audiences (Department of Education, 2015)

Transferable skills developed through discussion around science and its link with society



Communicating ideas	Public speaking
Considering ethics	Emotional intelligence
Interrogating sources	Critical reasoning
Anticipating risks	
Examining consequences	
Critical thinking	
Collaborative decision making	Teamwork
	Collaborative problem solving
Informed problem solving	Listening skills
Reflective thinking	Self reflection
Creative thinking and innovation	Imagination
	Innovation
Sense of Initiative	Confidence
	Using Initiative
Building a sense of responsibility	Leadership

Transferable skills developed through performance

Contents

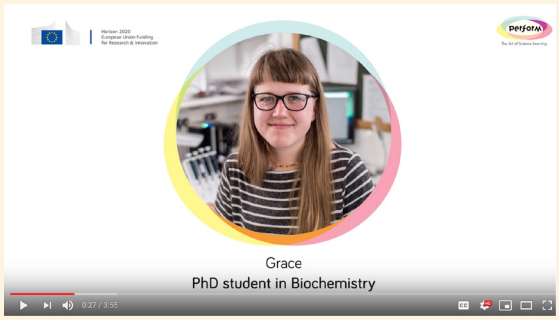
This toolkit consists of three main teaching resources: Performing Science cards, Meet the Scientist videos, and Guidance Notes for integrating these approaches into your lessons. Each of these can be used as a standalone resource or in conjunction with other components of the toolkit.

Performing Science activity cards

6 specially-created artworks each illustrate an ethical question relating to science and society. Alongside each artwork and corresponding question is a short performance-based or discussion-based activity and an outline of how to facilitate it within a classroom. A Science and Society card provides suggestions for deeper learning relating to the same ethical question.

Meet the Scientist videos

5 bite-sized videos each introduce an early career science researcher from the UK, France or Spain. These 5 minute long videos are designed to provide personal and relatable insights into careers in science and stimulate conversation about current scientific research and its potential implications for society. Each video is divided into two sections: in the Meet the Scientist section the researcher speaks about their own identity and career and in The Bigger Picture they reflect on ethical and philosophical issues related to their field of research. An accompanying guide provides further information on each featured researcher and suggestions for how to use the videos in the classroom.



Guidance for integrating these approaches into your lessons

Where should you start with integrating performance techniques into your classroom? How could you begin to introduce students to the bigger picture and how science affects us all as citizens? This section presents advice from performance and philosophy in schools practitioners from the PERFORM project.

Guidance on integrating performance techniques into science lessons

PERFORM invited teachers to use performance-based exercises to help explore issues around scientific research and its impact on society. This toolkit invites you to do the same. During the PERFORM training, we discussed some of the challenges teachers might face in using performance exercises in science lessons. Below are some suggestions to help you overcome these barriers and try out performance methods to enhance your teaching.

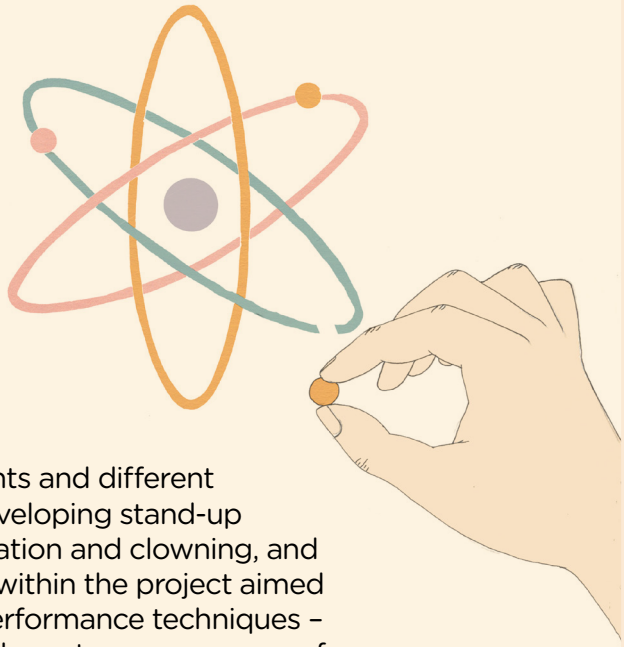
"I am worried that introducing performance will lead to a deterioration of behaviour in my lessons."

- Use of performance activities can actually help students to adopt behaviour that is positive and constructive for learning. Playful interactive teaching can help engage students with curriculum content.
- Using role play, the teacher can choose to take on a character through which they can control behaviour: a harsh Quiz Show Host or exacting TV interviewer, for example.
- Many performance exercises can include an element of scoring and reward. A reward or a sense of competition can help to focus students on the task at hand.
- In order to minimise disruptive responses to new performance elements in the classroom, start small. When introducing a new game or exercise, perhaps just do it for a few minutes at the end of a lesson.

"I already have so much to fit into my lessons. How can I ensure that these techniques enhance what they are learning and don't detract from the curriculum?"

- Many performance exercises are designed to re-focus and re-energise groups. As such, the rest of your teaching will benefit from their inclusion.
- Use the performance exercises as a way to recap and revise. This will also bring to your attention where there are gaps in knowledge and misconceptions.
- Some performance games are very short and by their nature can fit easily into lessons; these activities are designed to be short, adaptable, and easy to slot into a lesson.

What was PERFORM?



PERFORM was a 3-year EC research project during 2015-18 which investigated the effects of using performing arts methods to develop a deeper engagement with science subjects in selected secondary schools in France, Spain and the UK. It brought together students, teachers, performance artists and early career science researchers to develop interactive performances and engage in discussions about science and society.

Partners in each country worked with secondary students and different performance approaches; in Spain they focussed on developing stand-up comedy monologues, in France they explored improvisation and clowning, and in the UK they created science busks. Teacher training within the project aimed to build confidence in using general and easy-access performance techniques – building on the use of narrative, humour, role play and character - as a means of opening up dialogue on the relationship between science and society within the classroom.

Storytelling and drama are engaging ways of helping people to understand the societal and ethical implications of scientific research and to explore what that means for them on a personal level. Participants in PERFORM worked with performance-based techniques to reflect on their own role in the interaction between science and society, and the values embedded in the EC framework of Responsible Research and Innovation (RRI). RRI values underpin the RRI approach that anticipates and assesses potential implications and societal expectations with regards to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.

EC Horizon 2020: Responsible Research and Innovation

PERFORM philosophical discussion workshop, Bristol UK 2017

PERFORM performance training, Bristol UK 2017

Acknowledgments

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Illustrations by Harriet Lee-Merrion c/o Heart, heartagency.com
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How to use the Performing Science cards

These cards support students to explore ethical issues relating to scientific research and its impact on society. Each of the 6 sections is themed around one main ethical question.

Each Performing Science section contains:

- An Illustration
- Instructions for a Performance Activity
- Science and Society questions

Contents

How to use the Performing Science cards

Illustrations

Each image illustrates the main ethical question framing the section. The images can be used as a standalone resource to initiate discussion or alongside the Performance Activity or Science and Society questions.

Talking about the different elements within these artworks should support visual learning to interpret and reflect on the ethical question. Here are some ideas for use:

1. Show an illustration on the board and use it as a 'focusing activity' as students arrive into your classroom.
2. Get students to share their first thoughts: Describe what is happening in the image. What different images can you see? Do you recognise any signs or symbols? What do you like or dislike about it?
3. Ask students to 'read' and unpick the illustration. What question or message do you think the image is trying to communicate?
4. Ask students to write their responses as questions, phrases or single words on post-it notes and stick them onto the image at the front of the class.
5. You may choose to follow up on the post-it note questions or simply use this activity as a warm up.

How to use the Performing Science cards

Performance Activity

The cards provide instructions for a short Performance Activity that explores the main ethical question framing the section. The activities are quick and easy to manage within a classroom setting. They involve a variety of accessible performance techniques such as role play, prop-use, self-narration, characterization. The key explains the time required, type of performance and relevant transferable skills.

Before beginning, you will need to choose a scientific topic to be the focus of the activity - we have provided some Scientific Scenarios as examples.

Icon key

Time required

Performance method

Transferrable skills developed through activity

How to use the Performing Science cards

Science and Society questions

This section proposes additional questions to support a deeper exploration of the main ethical question framing the section. You can use the questions for standalone discussion, to extend the Performance Activity or to support exploration of the illustration. Draw upon the Scientific Scenarios and examples from the curriculum to contextualize the questions.

Scientific Scenarios

The Scientific Scenarios introduce examples of current scientific research, some of which are explored further in the Meet the Scientist videos. Many of the scenarios also link to topics taught in the English, French and Spanish science curriculums, so you can use them alongside curriculum teaching.

Discussion facilitation tips:

1. Make sure all students understand the question. Support students by asking them to highlight any words they don't understand, highlight key words or explain the question in their own words.
2. Give students time to consider their answers before whole class discussion. You could ask them to write their first thoughts (e.g. write continuously for a minute) or share ideas with a partner.
3. During whole class discussion it is important to emphasise that there are many good answers and no one right answer. Encourage students to respect and listen to each speaker and build on each other's ideas.
4. End discussion by inviting students to reflect on how their views have changed since the start of discussion and what they have learnt from others.

If research poses a risk to people or nature, should we still go ahead with it?

Performance Activity: Future Thinking

Select one of the Scientific Scenarios below or choose your own scenario.

Divide the class into 4 groups and give each group 5 minutes to create an innovative solution to the scientific scenario, which may itself pose potential risks. It doesn't have to be scientifically realistic- invite students to be as creative as they like!

Along with the idea, each group must also come up with a catchy title and a media-friendly strapline for their solution.

Each group then reads their title & strapline to the rest of the class. The class votes on which idea they want to hear more about.

The group with the winning idea now has 60 seconds to expand on their proposal to the class, explaining why their idea should be made a reality. It may help to get students to imagine they are pitching for funding to bring their ideas to reality.

Having heard the pitch, the other three groups then each take on one of the following roles. Give them 3 minutes to think about their arguments:

- Beneficiaries in 50 years' time. They have 60 seconds to say why the idea has been so good for them 50 years on.
- Critics in 50 years' time. They have 60 seconds to say why the idea has been so bad for them 50 years on.
- Panel of judges. They must weigh up the evidence from Beneficiaries & Critics to make a final decision as to whether the scientific solution should be developed or whether it is too risky.

15 minutes

Role play

Anticipating risk; Examining consequences; Creative thinking; Collaborative problem solving.

If research poses a risk to people or nature, should we still go ahead with it?

Science and Society Questions

See suggested Scientific Scenarios to use with these questions.

- What would happen in the future if the research to find a solution to this problem didn't go ahead? How would society lose out?
- Can you think of potential damage the research could cause? Do you think the benefits of this research outweigh the risks?
- Could we ever consider all the potential consequences of the research solution? How can we decide whether the solution should be developed if we can't know for sure what the consequences will be?

Scientific Scenarios

Earth's resources

Every single piece of plastic ever made still exists, and this plastic is causing harm to animals and nature. Scientists are currently researching solutions: alternatives to plastic and ways to reduce or better recycle the plastic we use, but plastic alternatives and reduction methods could create their own problems.

Disease

There has been an outbreak of a new disease that is causing an epidemic across the world. Scientists must find a way to combat and control the epidemic, but each combat and control method could carry risk.

Who should be involved in deciding which research projects get developed?

Performance Activity: Future Thinking (extended version)

Select one of the Scientific Scenarios below or choose your own scenario.

Divide the class into 4 groups & give each group one of the following identities; Global (World Leaders, UN, religious leaders etc), National (politicians, media, big businesses etc), Social (teachers, medics, police, shop keepers etc) and Domestic (families of all generations; parents, carers, children).

Each group must take on the viewpoint of their identity. Announce to the class that you have all travelled 50 years into the future. Give the groups 5 minutes to discuss the positive and negative impacts the scientific scenario has had on their group.

Acting as a news reporter, visit each group asking for their views: How has it benefited your community? Have there been any negative consequences to your job? How has your life changed since? Be as playful with this as you like.

To finish, get the class to vote on whether the Scientific Scenario was a good idea.

Get them to vote twice: once in character and then from their own personal viewpoint.

15 minutes

Characterization

Examining consequences; Considering ethics; Emotional intelligence; Collaborative problem solving.

Who should be involved in deciding which research projects get developed?

Science and Society Questions

See suggested Scientific Scenarios to use with these questions.

- Who will benefit most from this situation? Is any group of people going to be negatively affected by this situation?
- Who should be involved in making decisions about the situation? Should only the scientists working on this research or only people who will be directly affected have a say?
- If the public doesn't want this to happen but scientists do, whose opinion should be valued more?

Scientific Scenarios

Energy

Scenario 1: 50 years in the future, our society is dependent entirely on renewable energy.
Scenario 2: 50 years in the future, our society is dependent entirely on fossil fuels.

Universe

50 years in the future humans have discovered a habitable planet, people are trying to decide whether we should be allowed move there.


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Should we believe everything we read about science?

Performance Activity: Unbelievable Truth

Choose a topic that your class is revising, or one of the Scientific Scenario Topics below.

Give students 5-10 minutes to prepare a 1-minute presentation on a scientific topic. The presentation should consist entirely of made-up facts, apart from three concealed truths.

Invite a few students to present their 1-minute presentation to the class or smaller groups. Whilst the student presents what they have prepared, the listeners must listen carefully and stop the speaker if they think they hear a truth.

Listeners get a point for every correctly detected truth. The speaker gets a point if the listeners mis-identify a truth or fail to spot a truth.

Follow up questions:

- How easy was it to spot a truth?
- Which fake facts sounded more convincing? Why?
- Why did you believe some facts more than others?
- What helped you spot certain facts?
- Not everything reported about science in newspapers and online is true. Why do you think people might find it hard to tell the difference between true and false claims?

20 minutes

Self-narration

Critical thinking and reasoning; Interrogating sources; Listening skills.

Should we believe everything we read about science?

Science and Society Questions

See suggested Headlines from the Scientific Scenarios to use with these questions.

- Why do you think there are claims in the media that aren't true?
- Who is responsible for untrue claims about science in newspapers and online? Who might have a motive to influence what is reported?
- Why do you think it matters if untrue claims about science are reported?
- If people don't know what to believe, how might this affect their perception of science?

Scientific Scenarios

Use 'Topics' for the Performance Activity and 'Headlines' for the Science and Society Questions.

Topic	*Headline*
Robots	Robots are taking over human jobs
Genetics	Design your own baby
Nutrition	Chocolate helps you live longer

Should research always provide a direct benefit to society?

Performance Activity: The Mystery Object

Students should work in pairs or threes.

Option 1: Give the class 1 minute.
Each group must choose a random object from the classroom.

Option 2: You choose a random object for the whole class.

This object is now their scientific invention and each group must tell a story about it. It doesn't have to be scientifically realistic – invite students to be as creative as they like! Give students 3 minutes to prepare and then 1 minute to present their invention to the class.

After the inventions have been presented, discuss with the rest of the class:

- Which inventions will affect our future the most?
- Which inventions will have the most positive consequences? Which inventions will have the most negative consequences?
- If we could only develop one invention, which should we choose? Should we choose one that solves a world problem?

10 minutes

Prop-use

Critical thinking and innovation; Communicating ideas; Creative problem solving; Using initiative

Should research always provide a direct benefit to society?

Science and Society Questions

See suggested Scientific Scenarios to use with these questions.

- Does this research have an immediate benefit to society? How will it make people's lives better in the near future?
- If the research doesn't have an immediate or direct benefit, what do we gain from doing this research?
- If you had the power to develop one research project, would you choose one that directly tackles a world problem or one where we don't know yet if it will solve a problem?

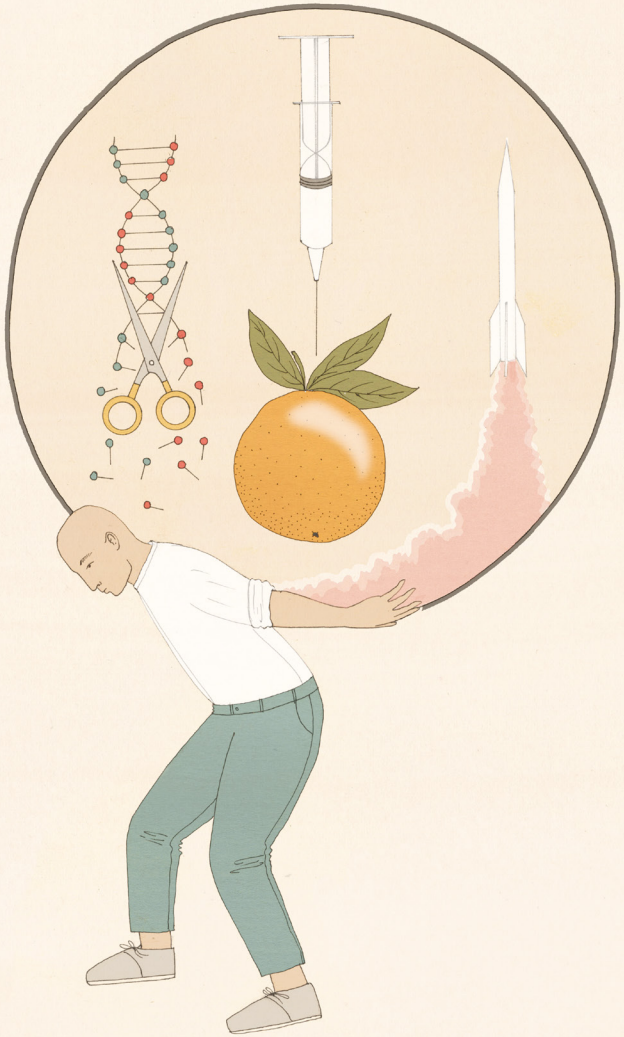
Scientific Scenarios

Extinction

Scientists are researching whether it might be possible to bring back the Woolly Mammoth from extinction. If they discover that it is possible, it could help humans bring back other extinct species.

Universe

Scientists are developing new technology that will help them learn more about far away galaxies. This could help us understand more about how our universe was formed. This research may also help scientists find planets in other galaxies that have the right conditions for humans to live.



Should scientists always be responsible for how their research is used?

Performance Activity: Scientist in the Hot Seat

Select one of the Scientific Scenarios below or choose your own scenario.

Explain to the class that sometimes research is not always used for its intended purpose and can be adapted for purposes that a researcher may not agree with.

Ask one student to sit in front of the class. They are now the scientist who has been working in this area of research. They have just found out that their research has been mis-used and they are now faced with a serious ethical dilemma. Invite the rest of the class to ask the researcher questions, for example: How does this make you feel? Did you have any idea this could have happened? If you had known before, would have stopped doing your research? Do you feel responsible?

Reflect on the activity, asking the class:

- What would you do if you were the scientist in this situation? Would you continue to work on this research?
- Did hearing a scientist's perspective help you consider a different situation or change your view at all?

10 minutes

Role Play

Reflective thinking; Considering ethics; Critical thinking and reasoning

Should scientists always be responsible for how their research is used?

Science and Society Questions

See suggested Scientific Scenarios to use with these questions.

- Scientists often now make their research findings publicly available, meaning the public and other scientists can access their findings. Is this a good idea? How could it affect the way scientists work?
- As citizens, should we all think about how our work (or behaviour) can have a positive effect on the future of humanity and the planet? What might the challenges be in thinking this way?
- If you were the researcher, and you found out your research had been dangerously mis-used, how would you feel? What might you do?

Scientific Scenarios

Chemical fertilisers

You are a researcher working on a process that allows fertilisers to be made, making farming more efficient. However, after you have retired you discover that your research is being used to create explosives.

GM Crops

You are a researcher working on genetically modifying tomatoes to make them have a higher nutritional value and higher yield. Governments across the world want to grow the tomato to increase food production. They don't want to restrict its planting which means that there is a risk that it will outcompete and take over native tomato species, dramatically changing ecosystems.

Why is it important to have a broad range of people involved in science?

Performance Activity: Tell Me Something I Don't Know

Select one of the Scientific Scenarios below or choose your own topic.

Arrange your class into pairs. Assign each student in a pair to be either Person A or Person B.

Without any preparation time, ask Person A to talk for a minute, telling Person B anything and everything they know about the chosen topic. It is important they know they can say anything, fact or opinion and should speak for the whole minute without stopping. Ask Person B to listen carefully, making a note of anything that they didn't know before.

Swap the roles around in the pairs and repeat the activity with the same topic.

Reflect on the activity, asking the class:

- Did you learn anything new from what your partner said?
- Was there anything you didn't agree with?
- Did your opinions on the topic change having listened to your partner's speech?
- Do you feel you know more about the topic having listened to each other?
- Why is listening to others important when doing science?

5 minutes

Improvisation

Communicating ideas; Reflective thinking; Listening skills; Using initiative

Why is it important to have a broad range of people involved in science?

Science and Society Questions

See suggested Scientific Scenarios to use with these questions.

- What do you think would happen if all the researchers working on this scientific topic were from one country or culture?
- Could there be any negative consequences of involving a broad range of researchers in this
- scientific topic?
- Do you think scientists know best about this scientific topic? How could the research be changed based on input from non-scientists?

Scientific Scenarios

Use 'Topics' for the Performance Activity and as examples for the 'Science and Society questions', using the notes as a guide.

Topic	*Notes*
Stem Cell research	Male and female researchers may bring a different perspective to research on embryo testing.
Deforestation	Researchers from different countries may bring different perspectives on the effects of deforestation.

Meet the Scientists

The videos in this section introduce students to real researchers from across Europe who are currently in the early stages of their careers. Showing these videos to your students should help to de-mystify what it is like to be a scientist and maybe even challenge some stereotypes!

The videos are in two parts, each around 2 minutes long. The first part *Meet The Scientist* introduces a researcher, reveals their reasons for going into their field of science and what it is like to be a scientist. This section will be helpful in supporting your class to explore careers in science and life as a scientist. The second part *The Bigger Picture* introduces some broader concerns linking their scientific topic to our lives as citizens, including some ethical dilemmas associated with their research. This part will be helpful for initiating discussion on science and society.

French, Spanish and English subtitles are available for all videos.

Meet Valentina in this video Click here >

Research Area:

Valentina works in the field of *biophysics*, developing new biophysical tools that can help to improve the quality of information about the cells in our body.

Valentina's Research:

Valentina looks specifically at muscle cells and moving cells in our body (i.e. cells in our blood). Actin and myosin are both involved in the contraction mechanism that helps muscles to contract and cells to move. So studying actin and myosin cells can enhance our understanding of how the contraction mechanism operates. To do this she uses fluorescent microscopy, which involves adding a fluorescent marker to our cell sample. This fluorescent marker can be attached to different molecules in the cell and Valentina can then study this fluorescent molecule under the microscope.

The Bigger Picture:

Valentina is working to create a tool that will help us understand more about how muscles contract and cells move around the body. This tool could be adapted to investigate cancer cells, to help us learn more about them and how they move around the body. If we can learn more about cancer cells and how they move around the body, this could help us get better at diagnosing cancers.

Questions:

- Valentina's research could one day potentially be used to help diagnose cancers. However it is still in the very early stages, so we cannot know for certain if it will. Do you think her research is worth spending public money on?
- What do you think you might find challenging about being a scientist? What might you enjoy about the kind of research Valentina is involved with?
- Why does Valentina think diversity in the science community is important? Do you agree?

Resources:

Concise summary about florescent microscopy: goo.gl/nUEwHa
Animation about florescent microscopy: youtu.be/u0CR-a0giS4

Meet Grace in this video Click here >

Research Area:
Grace works in a field called *genome engineering*, where she uses a tool which allows us to understand, and even edit, DNA. By trying to change this tool it can help us understand, and maybe even cure, a class of diseases called mitochondrial diseases.

Grace's Research:
Grace works with a technique for editing DNA which is called CRISPR. She is trying to modify the CRISPR tool to understand mitochondrial DNA better.

The Bigger Picture:
Grace's research is working towards creating a tool that should allow other scientists to understand mitochondria better. Mitochondria are found in all multicellular life (plants, animals, humans) and so understanding them better help us understand all life better.

Questions:
- How do you think people could mis-use genome editing?
- What fake or sensationalist news could people make up about Grace's research?
- What would happen if Grace's research didn't go ahead? Do you think it should be funded?

Resources:
Video on genome Engineering: youtu.be/jAhjPd4uNFY
Video on mitochondrial diseases: youtu.be/66Tjk8wtJYY

Meet Dani in this video Click here >

Research Area:
Dani works with *Swarm robotics*, which takes inspiration from swarms of animals like ants, bees, fish or birds. These animals work together in very large numbers and only communicate with their neighbouring peers. What defines a swarm is their ability to work collectively on tasks that they could not perform individually. Swarm robotics takes inspiration from swarm behaviours seen in nature and applies them to a large number of simple robots.

Dani's Research:
Dani specifically looks at self-organised shape formation. He designs computer systems for a swarm of 1000 robots so that they can grow a shape by themselves, without any map or human input.

The Bigger Picture:
In the future this research could be developed for search and rescue applications to help firefighters, but also to anyone who needs to be rescued in a dangerous situation. This technology could help firefighters find victims faster – 1000 robots could potentially explore the environment much quicker than several humans could.

Questions:
- Why do you think the public is wary of robots?
- Can you think of any ways in which the Swarm Robots could be mis-used?
- How do you think firefighters might feel about this type of research?

Resources:
Talk about how animal swarms and behaviour has led to swarm robotics: youtu.be/alH3yc6tX98
Video about how maths can explain patterns found in nature: youtu.be/F1hX_nzTlgU

Meet Joanna in this video Click here >

Research Area:
Joanna works in the area of *organic biochemistry*. She chemically synthesizes biomolecules which researchers are not able to manipulate by current techniques, for their use in fundamental cell biology research.

Joanna's Research:
Joanna is specifically researching glycolipids. Glycolipids have a really important role in maintaining the stability of a cell membrane and facilitating cell recognition: they help cells connect to one another to form tissue in our bodies. There is still a lot we don't know about them; their exact role, how they operate and how they interact with other cells. Scientists do have many techniques for synthetically creating DNA, but they do not yet know how to synthetically create glycolipids. Joanna is developing techniques to help us study these glycolipids in the lab. She will manipulate these glycolipids to do chemical reactions, outside the body in cell culture.

The Bigger Picture:
This research can help us study glycolipids; their activity and role in the cell membrane and as receptors. This will helps us understand how glycolipids can be used in fundamental cell biology. The more we know about them, the more we understand about the how the cells in our body work.

Questions:
- Joanna's research processes are costly and time consuming. Should we continue with research even if we are not sure whether there will be a beneficial outcome?
- Why might researchers overestimate the impact of their research?

Resources:
Concise summary about cell culture: goo.gl/Sgqd6N
Video on Cell membranes: goo.gl/jJ5Mjf

Meet Marina in this video Click here >

Research Area:
Marina's research area is in *astrophysics*, studying stars and searching for planets orbiting them, which we call exoplanets.

Marina's Research:
Marina looks at stars which are small and cold and studies how the light they emit changes with time. These changes could be due to a planet orbiting the star, so studying changes in the light emitted by stars could help find many more exoplanets.

The Bigger Picture:
By looking at other stars with planets, we can learn about how our own solar system formed and how it might evolve in the future. We know that in the future, many years from now, our sun will stop shining and life on Earth as we know it will not be possible, so humans may have to find another planet in order to survive.

Questions:
- Why do we want to know about exoplanets and where they are in the universe?
- Do you think if we find a planet that is perfect for human life we have a right to move there?
- What do you think about space tourism?

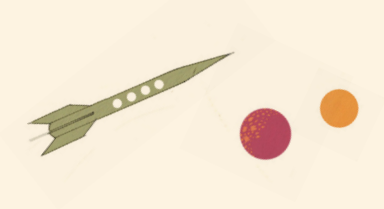
Resources:
How to find an exoplanet: youtu.be/cvET91EYoyc
How a star's light changes when a planet is orbiting it: youtu.be/-BuwWtMygxU

How to use the videos in your classroom:

Suggested activities to do *before* watching the video

Interview a scientist

- Choose a video and before watching, briefly introduce students to the research topic i.e. exoplanets or swarm robotics. For more information on each video see information on each researcher supplied in this document.
- Students should create a list of all the questions they have on this topic. After watching the video, get the students to discuss whether the video offered answers to their questions.



Challenge the stereotype

- Pause the video on any freezeframe of the researcher.
- Ask students to write down what job they think this person does and why?
- Watch first half of the video and get students to reflect on what they wrote.
  - What job does this person have? What does they daily routine look like? Did anyone guess their job correctly?
  - What surprised you in the video? Why.
  - What did they want to be when they were growing up? When did they decide they wanted to go into science? And why did they decide this? Does anyone feel the same?

Word association

- Before watching a video ask the class to write down three words that they associate with being a scientist.
- After watching the 'Meet the Scientist' part of the video, get them to rewrite these three words again. Then reflect on the following questions together
  - Did your words change at all? Did they change in a positive/negative way?
  - What kind of equipment/technology did they seem to use every day? What did their work environment look like? Was anything dangerous? Have you used any of the same equipment or processes?
  - Did anything surprise, excite or sound boring to you?

Draw a scientist

- Ask students to draw what they think a scientist looks like. You could even be specific and get them to draw an Astrophysicist or Robot Engineer.
- As well as drawing, ask students to create a list of typical characteristics of a Scientist.
  - What they look like?
  - What their work environment 'office' might look like?
  - What are their motives for doing what they do?
  - Describe what a day at work might look like
- Students drawings and lists can be shared with the class in a discussion to reflect on what their perceptions/misconceptions of science/scientist might be. Are they different from each other? Did everyone think the same? Where might this intrinsic stereotype come from.

How to use the videos in your classroom:

Suggested activities to do *after* watching the video

Debate the topic

- After watching the video, recap to make sure the class is clear on the research topic in question. Split the class into two, one group is for the research, the other group is against the research. Ask them to debate whether this research should receive more funding or not.

Write to a researcher

- Write a letter/email/message etc. to the researcher telling them what they like about their research or what concerns them about the research. Ask them to include two things they want to know about the research in the form of questions.

Pitch your research

- Show 2 of the videos and run an activity in which groups of students have to pitch the research presented in each video to funders for development.

Lights, camera, role play

- Ask students to imagine they were a science researcher. Ask them to decide which area of science they would research and write a script for a video like this, or even record an interview on camera !

This project has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement No 665826.

Guidance on integrating performance techniques into science lessons

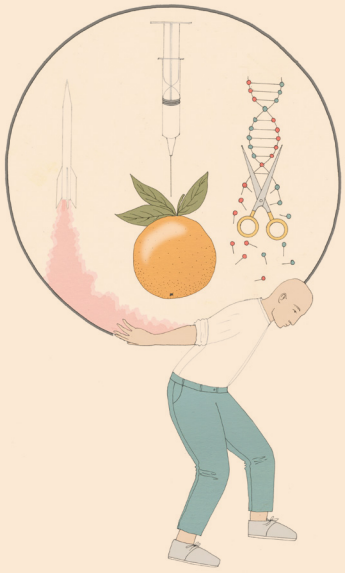
PERFORM invited teachers to use performance-based exercises to help explore issues around scientific research and its impact on society. This toolkit invites you to do the same. During the PERFORM training, we discussed some of the challenges teachers might face in using performance exercises in science lessons. Below are some suggestions to help you overcome these barriers and try out performance methods to enhance your teaching.

"I am worried that introducing performance will lead to a deterioration of behaviour in my lessons."

- Use of performance activities can actually help students to adopt behaviour that is positive and constructive for learning. Playful interactive teaching can help engage students with curriculum content.
- Using role play, the teacher can choose to take on a character through which they can control behaviour: a harsh quiz show host or exacting TV interviewer, for example.
- Many performance exercises can include an element of scoring and reward. A reward or a sense of competition can help to focus students on the task at hand.
- In order to minimise disruptive responses to new performance elements in the classroom, start small. When introducing a new game or exercise, perhaps just do it for a few minutes at the end of a lesson.

"I already have so much to fit into my lessons. How can I ensure that these techniques enhance what they are learning and don't detract from the curriculum?"

- Many performance exercises are designed to re-focus and re-energise groups. As such, the rest of your teaching will benefit from their inclusion.
- Use the performance exercises as a way to recap and revise. This will also bring to your attention where there are gaps in knowledge and misconceptions.
- Some performance games are very short and by their nature can fit easily into lessons; these activities are designed to be short, adaptable, and easy to slot into a lesson.



"I don't have enough space in my classroom."

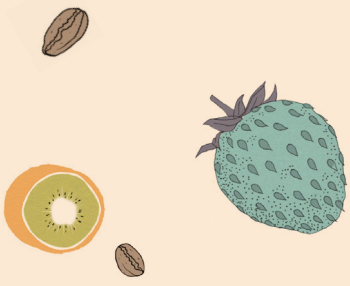
- Many performance techniques can be done sitting at desks or work-benches. Using your voice or getting into character, for example, are highly effective techniques for representing ideas in different way and encouraging students to consider different perspectives.
- Where techniques involve group-work, consider break-out spaces such as the corridor for quick conversations.

"I am not a drama teacher, so I don't feel confident using these techniques with my students."

- You are not teaching the students how to act or how to make plays. The techniques are just exploratory exercises that require a little creativity and imagination. Don't even call it 'drama', then the students won't even notice or have any expectations.
- If it helps, allow students to begin role-playing exercises in the 3rd person, describing how they think the character might behave i.e. "I think she would behave like this." If confidence improves you can suggest they move to 1st person later and begin to play out the character themselves.

"What about the students who aren't confident expressing themselves in this way?"

- Get students to work in groups and let more confident students be the spokesperson. Alternatively, you could get children to perform to smaller groups so it doesn't seem as daunting.
- Make opportunities for written role-play, rather than just spoken: 'write an email from your character...,' for example.
- There are normally other roles available for the less confident, which still keeps them involved: score-keeper or note-taker, for example.



Acknowledgements

This guidance on using performance exercises was based on ideas by Kilter Theatre, a theatre company who developed and delivered the PERFORM teacher training in Bristol UK 2017 and 2018.

Guidance on integrating discussion on science and society into science lessons

PERFORM encouraged students to build a more reflective understanding of science and its role in society, taking into account ethical and philosophical considerations, societal challenges and political concerns.

This toolkit invites you to do the same. This section provides best practice advice to help you to overcome potential barriers and effectively manage philosophical discussion with your class.

"There is already so much content for my students to learn. How can these philosophical discussions enhance what they are learning so that it doesn't detract from curriculum?"

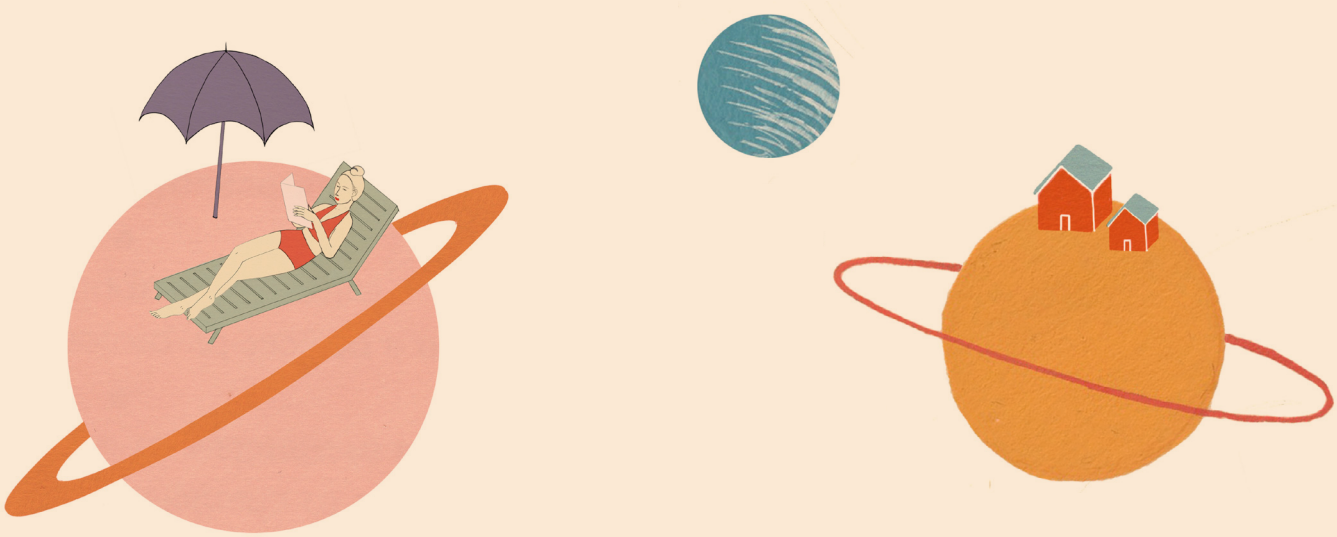
- Quick 5/10 minute discussions can be slotted into lessons as starters or plenaries; they do not have to take up the whole lesson.
- Many philosophical discussions will help clarify key terms in the curriculum and consolidate content knowledge. You can use discussions as a tool for revision, identifying gaps in knowledge and diagnosing misconceptions.
- These discussions provide a new perspective and context to curriculum content. For some students, engaging in these discussions can help to humanise the scientific topic and make it more relevant to their lives. This can help improve engagement in lessons.

"As a science teacher I am not trained in facilitating philosophical or ethical discussions."

- It helps to introduce these discussions as collaborative discussions and not a debate. Encourage students to share and build on each other's ideas, disagree constructively and even change their minds!
- There are lots of easy facilitation techniques, such as 'think-pair-share', which encourage participation from all students and help build an ethos that encourages contributions from everyone.
- Try using facilitation questions such as 'what would someone who disagrees with you say?' and 'why do you think that?' to encourage depth and focus discussion, rather than giving your own opinion or doing too much of the thinking for your students.
- If you are interested in finding out more about facilitating philosophical dialogue, there are lots of online resources on P4C (Philosophy for Children) and you may even want to consider training with SAPERE.

"I am used to encouraging a scientific discussion based on facts; I am worried about engaging the students in a discussion that doesn't necessarily have a right or wrong answer."

- Although philosophical questions cannot be answered with empirical evidence alone, many discussions do depend at least in part on scientific knowledge. Although there may not be one correct answer, there are better and worse answers; an answer that is well thought through and is backed up by good reasons is better than an answer that is not.
- Progress in these discussions is not through coming to 'an answer' rather, coming to a better provisional understanding and working better as a group to advance understanding. Rethinking progress in this context can avoid students feeling that the conversations are pointless when they do not result in a clear factual conclusion.



Acknowledgements

Guidance on integrating discussion was written by Ellie Hart (Philosophical practitioner, University of Bristol) and Ellie Cripps (Public Engagement Associate, University of Bristol), who created the 'Thinking Science' teaching resource for encouraging philosophical dialogue in the science classroom.

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