SECONDARY LEVEL

WATER FOR EVERYONE EVERYWHERE

SLIDE NOTES

Water for Everyone Everywhere is a hands-on enquiry-based workshop that enables pupils to explore the global issues associated with water access and the role that engineering plays in water distribution.

UK ENGINEERS WITHOUT BORDERS

This document has been produced by Engineers Without Borders UK.

Last dated update of this document: 09 September 2019.

This document and the accompanying materials are available to download from: www.ewb-uk.org/water-for-everyone-everywhere.

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OVERVIEW

Water for Everyone Everywhere is a workshop designed to encourage pupils to explore the challenges associated with access to safe and clean drinking water around the world. Pupils learn about the importance of water to people's everyday lives and the role that engineering infrastructure plays in the distribution of water. Pupils design, build and test their own model water filter as part of this workshop. This workshop builds on the Sustainable Development Goals and the concept of global citizenship.

This document is a guide for Engineers Without Borders Ambassadors delivering the presentation. Teachers and youth group leaders can also use it. It should be used in conjunction with the accompanying slides as well as the Facilitator's pack and printouts. Please note that this resource is periodically updated. The date of the last update is on the inside front cover.

If you are not a teacher/youth group leader, please sign up to become an Engineers Without Borders Ambassador to be able to deliver this resource. Find out more and register here from our website. For any queries, please contact Engineers Without Borders UK directly using the email address: outreach@ewb-uk.org.

CONTENTS

INTRODUCTION: HOW WE USE AND RELY ON WATER

SLIDE 1: OPENING SLIDE

Display as class enter, if you arrive before them.

SLIDE 2: AMBASSADOR INTRODUCTION

Introduce yourself and anyone else running the session. Each tell the pupils about yourself.
If you are a university student tell the class your:

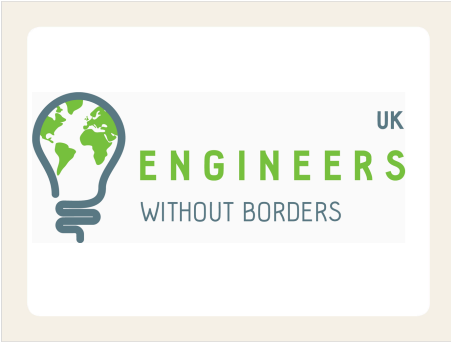
- Name
- University
- Year of study
- Course
- Career plans

If you are not a university student tell the class your:

- Name
- What you studied at university/college
- Profession
- Field of work

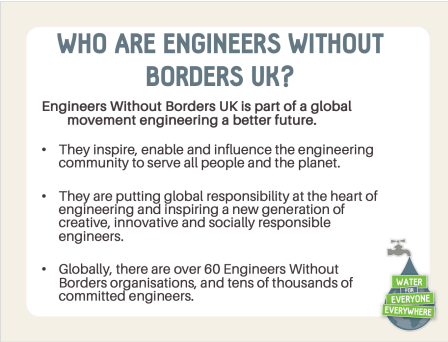
Explain that you are delivering a workshop designed by Engineers Without Borders UK. You could also briefly explain how you got involved with Engineers Without Borders UK.

SLIDE 3: WHO ARE ENGINEERS WITHOUT BORDERS UK?



Explain that you are teaching a workshop created by Engineers Without Borders UK.

SLIDE 4: WHO ARE ENGINEERS WITHOUT BORDERS UK?



Introduce Engineers Without Borders UK, a UK based charity engages and galvanises the engineering community to serve all people and our planet better than ever before.

SLIDE 5: HOW YOU USE WATER?

Starter task

- Ask the class to put their hands up with suggestions or prepare A4/A3 paper on tables/use a flipchart.

Summarise the class's response to your question:

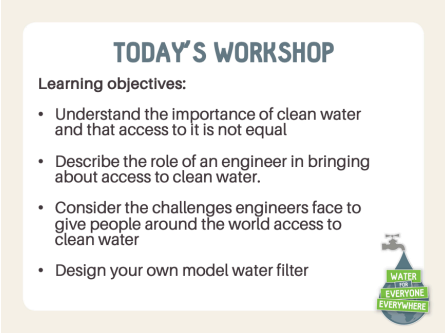
- Water is used by us for drinking; washing ourselves; washing our clothes; washing kitchen pots and pans, cars, our pets, the windows; it moves our waste around the sewage system; it's used in radiators to heat rooms; it's used in farming to irrigate our crops and water our animals; it's used in industry for making food and drink, dying clothes, producing products; it's even used in generating electricity where it is used to cool down parts of the generation process.
- Emphasize the two central pictures, as these are non-direct/hidden ways we use water (food and manufacturing).

SLIDE 6: INTRODUCTION

Following the starter task:

- Introduce the session as 'Water for Everyone Everywhere'.

SLIDE 7: TODAY'S WORKSHOP

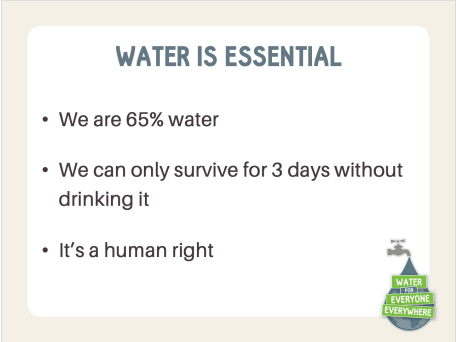


Summarise the overall aim of the workshop: to deepen their understanding of what engineers do and the global challenges that engineers are working to address.
Share the learning objectives of the workshop, explaining what they will be doing to meet each one:

- Understand the importance of water and access to it is not equal - To do this the class will be looking at case studies from locations across the world.
- Describe the challenges engineers face to enable people around the world to have access to clean water - Throughout the workshop the class will be learning the key role engineers play in the different stages of allowing access to water.
- Consider the challenges engineers face to give people around the world access to clean water – Reflection scenario activity to think about how innovative engineering can be used to give people access to clean water.
- Design your own model water filter - The class will be showing engineering skills in a practical activity to design, build and test out the performance of their water filter.

THE IMPORTANCE OF WATER AND HOW WE USE IT INDIRECTLY

SLIDE 8: WATER IS ESSENTIAL



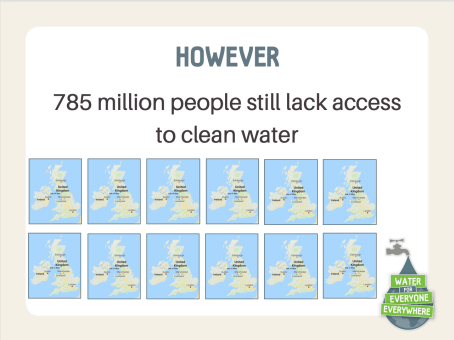
Talk through the facts. Elaborate:

- We are 65% water [1] – get the pupils to think about what in the body is made mostly from water: blood, spit, phlegm etc.
- We can only survive for 3 days without drinking it – less if it is very hot and you are sweating a lot, as little as 1.5 days [2].
- It's a human right – everyone in the world deserves access to water, and it is their legal right, but it is still difficult to give everyone access to clean water.

[1] http://www.unric.org/en/water/27360-making-water-a-human-right

[2] https://www.usgs.gov/special-topic/water-science-school/science/water-you-water-and-human-body?qt-science_center_objects=0#qt-science_center_objects

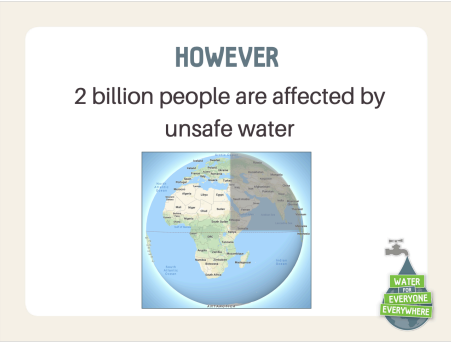
SLIDE 9: HOWEVER



Put this number into context - this is about 12 times the population of the UK.

https://www.who.int/news-room/fact-sheets/detail/drinking-water

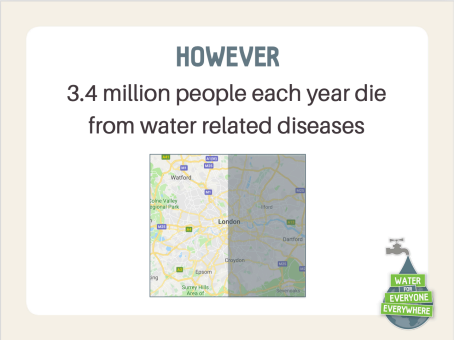
SLIDE 10: HOWEVER



Put this number into context - this is about a quarter of the population of planet Earth.

https://www.who.int/news-room/fact-sheets/detail/drinking-water

SLIDE 11: HOWEVER



Put this number into context, this is about half the population of Greater London.

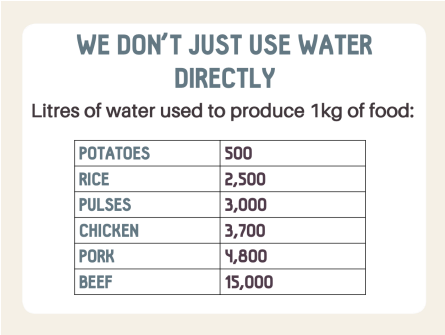
https://www.who.int/water_sanitation_health/takingcharge.html

SLIDE 12: WE DON'T JUST USE WATER DIRECTLY

Explain that water is used in ways that we cannot see. It is required to grow crops, which are needed to feed us and animals, and required for the manufacturing process of almost everything we use in our daily lives.

http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW04_1.0.pdf

SLIDE 13: WE DON'T JUST USE WATER DIRECTLY



POTATOES	500
RICE	2,500
PULSES	3,000
CHICKEN	3,700
PORK	4,800
BEEF	15,000

- Explain that some foods require more water to produce than others. This is because plants need water to grow, and animals need to eat lots of these plants, so meat requires more water per kg than vegetables. Point out the huge difference between the water required for chicken/pork and beef.
- Explain that dairy products come from cows, so also require a lot of water (mainly to keep the cows alive, but also for cleaning and processing) – even more water is needed than to produce chicken meat!
- Fun Fact! It takes 30L of water to make a cup of tea. This is because tea is a plant which needs water to grow.
- **Note:** you may need to explain what pulses are. Pulses are edible seeds from plants, examples include peas, beans, chickpeas and lentils.

- You can save water by thinking more about the things you eat – you could choose to eat chicken instead of beef, replace some meat with pulses, or stop eating dairy.

http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW04_1.0.pdf

SLIDE 14: WE DON'T JUST USE WATER DIRECTLY

- Explain that the image is a picture of a cotton field, and that the plant produces the fibres which we pick and use to make clothes.
- Cotton plants need watering a lot to keep them alive. Therefore, producing a cotton t-shirt requires a lot of water, even if we ignore all the water used in processing and dying the fabric.
- We can save water by only buying the clothes we need and buying them second-hand then donating them to a charity shop or selling them on afterwards.

[1] http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW04_1.0.pdf
[2] https://www.worldwildlife.org/stories/the-impact-of-a-cotton-t-shirt

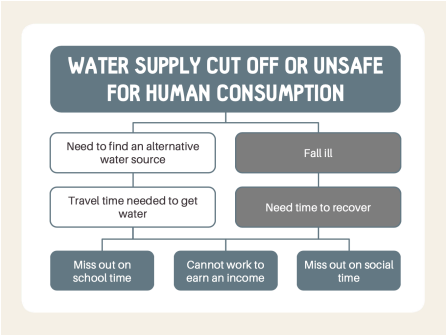
SLIDE 15: WE DON'T JUST USE WATER DIRECTLY

- Technology requires vast amounts of water from:
  - Extracting the materials from the ground
  - Cooling the machinery in the factory
  - Washing the microchip hundreds of times, so that it is clean enough to function
- We can save water by taking care of our technology, so that it doesn't need replacing as often.
- We can return our old technology to the manufacturer, donate, or recycle it.

[1] https://waterfootprint.org/en/about-us/news/news/grace-launches-new-water-footprint-calculator/
[2] http://www.miwaterstewardship.org/youthstewards/factsaboutwater/testyourknowledge/yourwaterconsumption

ACCESS ACTIVITY: WHAT IF I DON'T HAVE ACCESS TO CLEAN WATER? HOW DOES EVERYONE EVERYWHERE GET ACCESS TO CLEAN WATER?

SLIDE 16-27: THE IMPACT OF NOT HAVING ACCESS TO CLEAN WATER



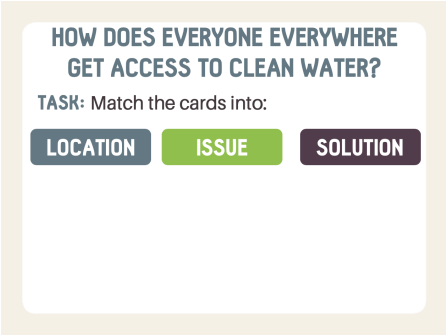
Using the graphic, address the consequences to peoples' lives of not having access to clean water.

- Explain that when your life is affected in this way, you may choose to search for an alternative water source.
- It takes time to find clean water and bring it to where you need it.
- The time taken up to do these things may mean that you miss out on things like:
- school and an education
- which in turn may reduce your future chances of employment
- this can reduce the amount of money you have to buy food and other items

- It may also mean you have less time to socialise with your friends and family. Explain that when your life is affected in this way, you may choose to drink the dirty water that you have access to, resulting in you falling ill.
- If you fall ill, you need time to recover.
- The time taken up while recovering may mean that you miss out on things like:
- school and an education
- which in turn may reduce your future chances of employment
- this can reduce the amount of money you have to buy food and other items
- It may also mean you have less time to socialise with your friends and family.

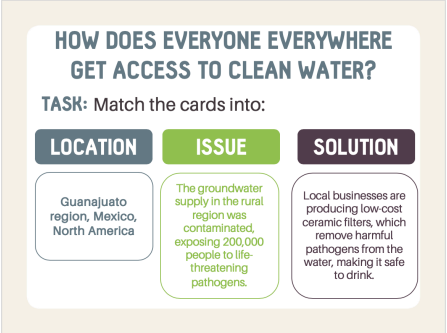
- Use this slide to do a quick recap on how vital water is to us, and what can happen when we lack access to safe, clean water.
- Lead into the next slide by concluding that because water is such an important resource for everyone on the planet, but it is difficult to bring it to us where and when we want to use it, it is very important that we look after it, and treat it as the precious resource that it is.
- We should all be careful to conserve water as best we can – e.g. we should not be wasteful with it.

SLIDE 28: CARD SORT ACTIVITY



Explain that the class are going to be looking at four case studies that highlight how different communities around the world are addressing issues relating to access to clean, safe water.
The first case study is already solved, as an example. Read through the next few slides, to give the class an idea of what to do for the activity.

SLIDES 29-31: GUANAJUATO CASE STUDY – CARD SORT ANSWERS



When reading through the example case study, answer any questions from the pupils if they do not understand the matching process.

Note: Coloured blocks appear one after another as you progress through the slides.

SLIDE 32: GUANAJUATO CASE STUDY

Discuss that the picture shows the clean water, after being pumped through the ceramic filter which removed the harmful pathogens.

SLIDE 32: GUANAJUATO - FULL CASE STUDY NOTES

Full case study notes:

- This is an example about the water challenges facing people in rural Mexico.
- Highlight that water contamination is a problem because people in rural areas are used to drinking water without filtering it, and often do not have access to filtering equipment.
- It is important to filter the harmful pathogens out of the water so that people do not get sick from drinking it.
- Each filter can clean one litre of water per hour, lasts two to three years and is so cheap that the clean water from these filters is 100 times cheaper than bottled water.
- The people of Guanajuato can now drink clean groundwater, save money on bottled water and reduce plastic waste.
- Local businesses are also benefiting as they produce, maintain and distribute filters, and make bricks for the kilns which bake the ceramic filters.

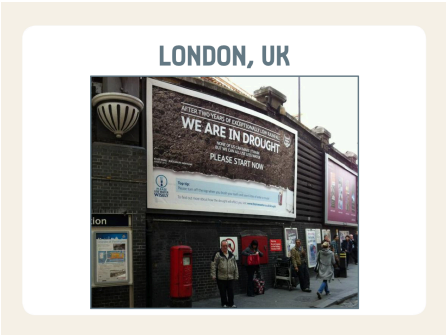
https://wordpress-86870-559398.cloudwaysapps.com/projects/clean-water-in-mexico/

SLIDES 33-35: LONDON CASE STUDY – CARD SORT ANSWERS

Use these slides to go over correct card matching.

Note: Coloured blocks appear one after another as you progress through the slides.

SLIDE 36: LONDON CASE STUDY



Discuss that the picture shows a poster, that the university group were asked to produce, to encourage people to reduce their own water consumption.

[1] http://www.bbc.co.uk/schools/gcsebitesize/geography/water_rivers/drought_rev4.shtml
[2] https://www.trustforlondon.org.uk/data/londons-population-over-time/
[3] http://www.wrap.org.uk/content/water-efficiency-case-study-london-metropolitan-university

SLIDE 36: LONDON - FULL CASE STUDY NOTES

Full case study notes:

- This is an example about the water challenges facing people in the South East of England.
- Highlight that water scarcity is prominent in the South East of England due to the amount of people that live there, the amount of water they demand every day and the low rainfall they experience [1].
- With the population set to grow, particularly in London where there are already over 9 million people living there, it is essential that the current water distribution systems are as efficient as possible to ensure that water does not get wasted or lost. This also means that people need to take action themselves to preserve the local water supply [2].
- Rachel Ward, the Energy Manager at London Metropolitan University managed to get their pupils to reduce the university's water consumption by 1,183 cubic metres. They have achieved cost savings of around £2,350 through water awareness activities. [3]

SLIDE 37-39: MEXICO CITY CASE STUDY – CARD SORT ANSWERS

Use these slides to go over correct card matching.

Note: Coloured blocks appear one after another as you progress through the slides.

SLIDE 40: MEXICO CITY CASE STUDY

Discuss that the picture shows residents installing a rain water harvesting system. The collection of rain water is much cleaner than the contaminated lake water but still has risks to drink.

SLIDE 40: MEXICO CITY – FULL CASE STUDY NOTES

Full case study notes:

This is an example is about Mexico City in Mexico, Central America.

- Mexico City was built by the Aztecs over five lakes, and experiences frequent flooding throughout the rainy season every year.
- Although there's plenty of water, the city faces serious shortages in supply of water to its 21 million people.
- Unfortunately, the water in the lakes under the city is contaminated from the sewage of all those people so it's not suitable for human consumption.
- Instead, water is piped into people's homes from containers that are filled using water sources from outside city. This is extremely expensive for the city's residents. [1]
- Whilst residents wait for Mexico City's government to improve the sewage system and clean up the lakes so that they can get cheaper water from the lakes, many of the local residents are finding other ways to get water.
- This is the home of Eusebia Santa Ana Gutierre; she and her neighbors are collecting the rain that falls during the rainy season themselves. This means that they do not have to pay for containers of water anymore and are able to wash their clothes and dishes as they please, and drink water and shower without too much worry. [2]

[1] http://www.aljazeera.com/focus/2010/03/201032982731685235.html
[2] http://www.pri.org/stories/2013-01-31/mexico-city-harvesting-water-sky

SLIDE 41-43: BAMBUI CASE STUDY – CARD SORT ANSWERS

Use these slides to go over correct card matching.

Note: Coloured blocks appear one after another as you progress through the slides.

SLIDE 44: BAMBUI CASE STUDY

Discuss that the picture shows residents installing a rain water harvesting system. The collection of rain water is much cleaner than the contaminated lake water but, still has risks to drink.

SLIDE 44: BAMBUI – FULL CASE STUDY NOTES

Full case study notes:

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[1] http://www.aljazeera.com/focus/2010/03/201032982731685235.html
[2] http://www.pri.org/stories/2013-01-31/mexico-city-harvesting-water-sky
Image: Testing the water flow in the BAWA water system. Credit: Fernando Matoso, Reignite.

SLIDE 45: THE SUSTAINABLE DEVELOPMENT GOALS

Introduce that alongside local action, global leaders are also taking the issue of access to clean safe water seriously.

- In 2015, global leaders from countries all over the world made a commitment to take 17 global challenges seriously and aim to address them all over 15 years (up to 2030).

https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Image: http://www.globalopportunitynetwork.org/sustainable-development-goals-reconnecting-businesses-with-society/#.VkCT-67hDMU

SLIDE 46: THE SUSTAINABLE DEVELOPMENT GOALS

The world leaders recognise that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

The 6th Sustainable Development Goal is related to giving people access to water.

https://sustainabledevelopment.un.org/?menu=1300

SLIDE 47: THE SUSTAINABLE DEVELOPMENT GOALS

The aim of the 6th Sustainable Development Goal is to ensure that everyone everywhere has access to clean water and sanitation, by 2030.

https://sustainabledevelopment.un.org/?menu=1300

SLIDE 48: WHERE CAN WE FIND WATER?

As an engineer looking to solve the issue of bringing water to where it is needed, the first question we need to ask is this:

- Where can we find water?

Ask the class to think back to the case studies, and ask:

- What was the source of water harnessed by the community in Mexico City to increase their access to water? (rain water)

Ask the class to name any other sources of water.

SLIDE 49: WATER SOURCES

Summarise the class's response to your question with this slide.

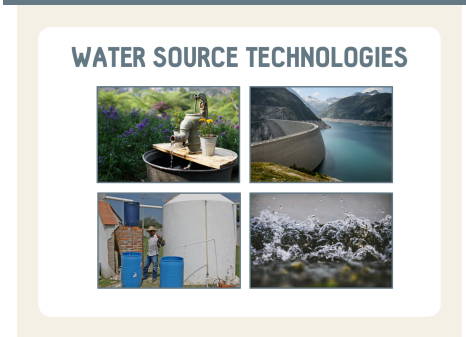
- Water is found under the ground (known as 'ground water' or an 'aquifer');
- Surface water from rivers, streams and lakes;
- It falls from the sky as rain;
- Water is in the sea (albeit very salty water).

SLIDE 50: HOW CAN YOU COLLECT WATER FROM THESE SOURCES?

- Following on from the previous slide, highlight to the class that once you've found the water, you have to collect it so that we can use it.
- This will be different to how we get water from out of the ground.
- Ask the class to answer this question – How can you collect the water from these sources?

Again, you could either have pupils shout out answers and then you reiterate them or, you could use a white board / flip chart to list them down for all to see. Or, you could run through the answers yourself, especially if you are running behind schedule!

SLIDE 51: WATER SOURCE TECHNOLOGIES



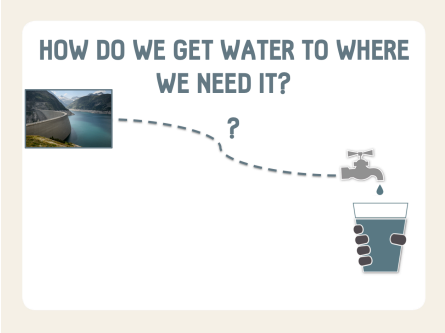
Summarise the class's response to your question with this slide / run through these yourself without asking the class

- Ground water is accessed and collected using wells and boreholes – if you dig deep enough to below the level of the water under the ground, the water collects in the hole you have created, you can then lift it up to ground level using a bucket or a pump.
- Surface water is collected using dams and reservoirs, you are blocking the water from going somewhere else so it's there for when you need it.

- Rain can be collected using 'rainwater harvesting techniques'. In most cases this is by collecting the water running off flat surfaces like roofs or be big funnels designed specifically for rainwater collection (as in the Mexico City case study).

Sea water must have the salt removed, this is a process called 'desalination', it is currently very energy intensive, therefore expensive, so getting our water from the sea is to be avoided as much as possible, but for many people in the world it is their main source of water, like those who live in desert regions.

SLIDE 52: HOW DO WE GET WATER TO WHERE WE NEED IT?



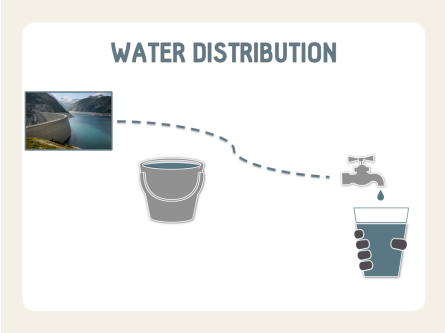
Explain that once we've managed to find and collect the water, the next thing an engineer needs to do is get the water to where we want to use it. Mention that in many cases the water is a long way from where we want to use it.

So, ask the class to answer this question:

- How do you think that water is taken from where we collect it to where it needs to be used

You could either have pupils shout out answers and then you reiterate them or, you could use a white board / flip chart to list them down for all to see. Alternatively, you can run through this yourself, especially if you are running behind schedule!

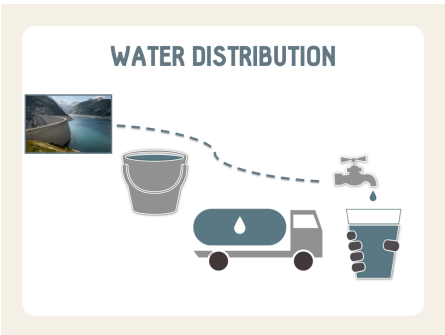
SLIDE 53: WATER DISTRIBUTION



Summarise the class's response to your question with this slide / run through these yourself without asking the class

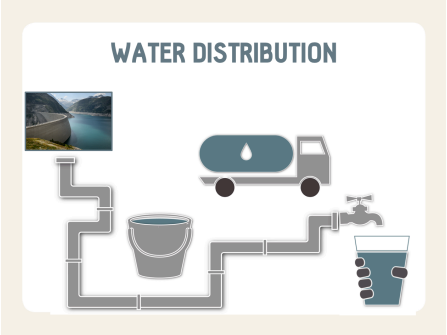
- You can go and get it yourself in a bucket

SLIDE 54: WATER DISTRIBUTION



- You could fill a tanker up with water and drive it to where it is needed

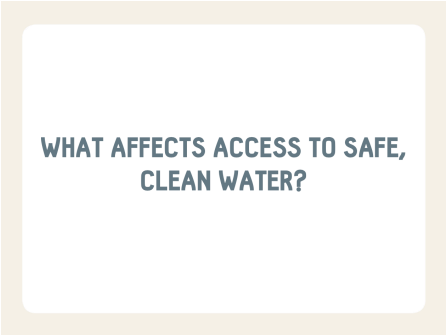
SLIDE 55: WATER DISTRIBUTION



You can put pipes in place to distribute the water (this is generally how we get most of our water in the UK)

Conclude by saying – we've now worked out how to find water, collect it and then distribute it to where we need to use it!

SLIDE 56: WHAT AFFECTS ACCESS TO SAFE, CLEAN WATER?



Explain that we have looked at how engineering brings safe, clean water to you to use. However, it is not always an easy exercise and that is what makes it a challenge.

SLIDE 56: OPTIONAL ACTIVITY

Optional activity:
Explain that we are now going to do a small activity to reflect on this question and explore what factors affect access to safe, clean water.

- Give each group a scenario card and tell them that they need to explain the impacts of the situation and identify factors they must consider and further information they would need, to better understand the context of the issue before thinking about an appropriate solution.
- Give the class 2 minutes to read the scenario, 5 minutes to share ideas that they will present. Reassure groups that there is no right answer and that this would be an initial step in attempting to solve different challenges.
- You can challenge groups to further suggest what suitable solution ideas they initially have to help address the issue.

Notes: Use the information to support group discussions on each scenario.
Scenario 1: challenges of getting access in the first place
You are a population living high up a mountain, that are not connected to a water source. Materials are expensive to install pipes and technical know-how is scarce

- It could be that the terrain and distance make it hard for the water distribution system to reach the population.
- It could be too expensive, and the money isn't available
- It could be that there currently aren't enough materials available to put the water pipes in place or that there aren't currently enough people who know how to put the pipes in place available to come and build it for them – installing water pipes can be dangerous and requires technical knowhow about how it all works, if they need help with this suggest they think about a time something has broken at home and how long it has taken for someone with the right skills to come and fix it.

Scenario 2: challenges of a Technical failure
You are population that had access to water but due to problem in the water distribution system, you are no longer connected. Other populations downstream of the system are also affected.

- Even once you have access to water, there are factors that could mean this access is affected.
- A technical failure/breakdown of the water distribution system could mean that you no longer have access to water. This could be due to not maintaining the system, or something breaking the pipework affecting the reliability of the system.
- Access issues in on place can have knock on effects for others downstream of the distribution system.
- Pupils could consider the practical and economic aspects of this scenario.

Scenario 3: challenges of Demand changes
Your population is continually and rapidly increasing due to large numbers of people moving and building families to urban areas. Materials to install pipes are expensive and technical know-how is a limited resource.

- When the population increases but the existing system was only able to support the previous population size Now that there are more people demanding water in the same place there isn't as much water for each person as there was before.
- Suggest that the people living here might need to change their day to day use accordingly otherwise there won't be enough for everyone. If there's enough money, materials and skills then a bigger system can be built to provide more water, but this will take time.
- The same problem would occur if the existing population had changed their lifestyles to demand more water. Conclude by saying that another factor affecting access to clean, safe water is the balance between available supply and the human demand.

Scenario 4: challenges of Supply issues

You are a population that rely on a rain water harvesting system. There has been a significant reduction in water supply this year. Materials and skills to build new generation centres is costly.

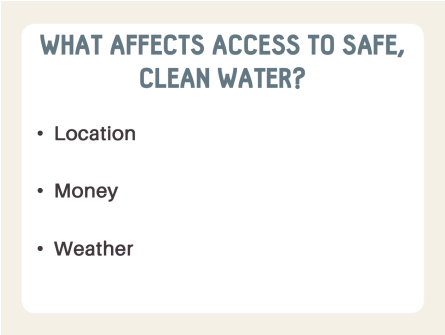
- A significant reduction/no rain this year would mean no/little rainwater could be collected for the water distribution system.
- Water is a natural resource its availability is a significant factor affecting access to water. Pupils can consider the impacts on the environment of different water collection systems (e.g. driving containers of water will contribute to carbon dioxide emissions).
- Pupils could consider the practical and economic aspects of this scenario.

Scenario 5: challenges of Contamination

Sewerage is entering the ground water supply, that your population relies on. Other populations downstream of the system are also affected.

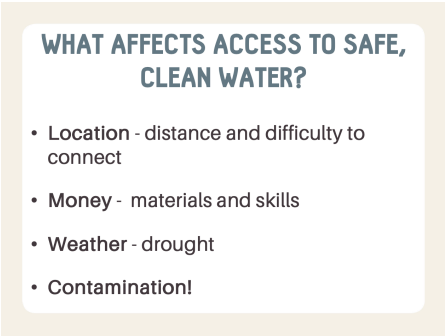
- The sewerage system could have broken, and sewerage is now entering the ground water supply. It has been contaminated by biological contaminants that are potentially very harmful if drunk.
- People's lives are affected by consuming contaminated water and that contamination, and the threat of contamination, is another factor affecting access to safe, clean water.
- Access issues in on place can have knock on effects for others downstream of the distribution system.

SLIDE 57: WHAT AFFECTS ACCESS TO SAFE, CLEAN WATER?



- Use this slide to summarise the key factors that affect access to safe, clean water by referring to the bullets on the slide.
- Ask the pupils to think of specific things which stop people getting access to clean water, which are related to the bullet points, and have them call out answers.

SLIDE 58: WHAT AFFECTS ACCESS TO SAFE, CLEAN WATER?



- Summarise the main factors which prevent people from gaining access to clean water, from the slide.
- Conclude the activity by highlighting how difficult it is to get access to safe, clean water and therefore engineers have to work hard when it comes to bringing us water that is safe to drink.

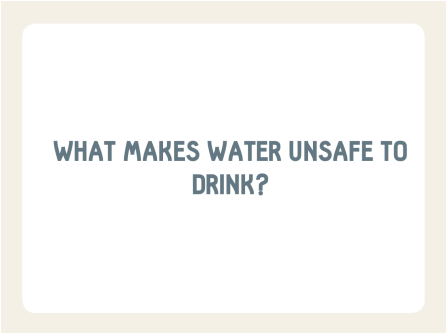
SLIDE 59: WHAT HAVE WE FORGOTTEN?

Explain to the class that you think we've missed a vital step!

SLIDE 60: WHAT HAVE WE FORGOTTEN?

Have the class take another look at the steps to access water and see if they can spot what we have missed – that the water has not been treated, so it is not clean!

SLIDE 61: WHAT MAKES WATER UNSAFE TO DRINK?



Explain to the class that to make water safe, we need to understand what makes water unsafe. Therefore, we need to ask:

- What makes water unsafe?

There are several things that makes water unsafe to drink, we refer to them as 'contaminants'.

SLIDE 62: CONTAMINANTS MAKE WATER UNSAFE TO DRINK

- There are several things that makes water unsafe to drink, we refer to them as contaminants.
- Define a contaminant for the class, by using the Oxford Dictionary definition on the slide.

SLIDE 63: PHYSICAL CONTAMINANTS

Briefly describe these examples:

- Physical contaminants- usually larger bits of dirt or rubbish. Things that you can see, which visibly make the water look dirty.
-
- Example: dirt, making the river brown

SLIDE 64: BIOLOGICAL CONTAMINANTS

Briefly describe these examples:

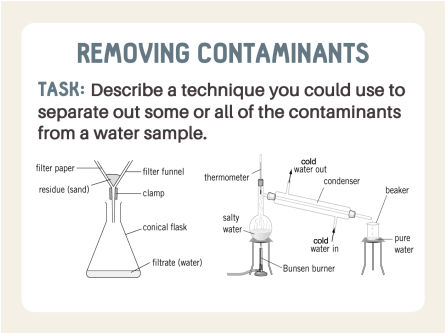
- Biological contaminants- harmful germs that can cause diseases. Things like bacteria and viruses.
-
- Example: bacteria, making the water green by photosynthesising to produce chlorophyll

SLIDE 65: CHEMICAL CONTAMINANTS

Briefly describe these examples:

- Chemical contaminants- harmful chemicals that could be poisonous, such as fertilisers, pesticides, petrol, cleaning products/bleach.
-
- Example: fertiliser, causing algae blooms

SLIDE 66: REMOVING CONTAMINANTS



Ask the class if they have studied techniques to separate mixtures and if they recognise the equipment/ techniques displayed.

- If the class are unsure, explain that mixtures are made up of two or more different components that are not chemically bonded together. Explain that the first diagram shows the filtration technique and the second distillation (try not to give too much detail).
- **Optional activity:**
- Give the class 3 minutes in small groups to discuss techniques to separate contaminants that are mixed in water collected from the source. Remind them they can use the techniques on the board for ideas.
- Go around the group encouraging novel ideas and asking what equipment they would require.

Share a few responses of a few groups.

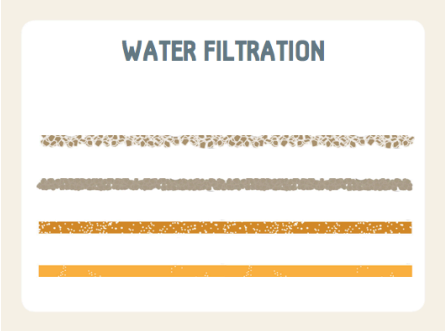
SLIDE 67: SAFE WATER

Conclude your explanation of contaminants by referring back to this diagram showing the water system.

- Explain to the class that as well as getting or improving access to water, as engineers it is important to make sure that the water is safe, particularly if people are going to drink it.
- That means either preventing the contaminants from entering the water system in the first place or removing them.

BUILD ACTIVITY: BUILDING A WATER FILTER

SLIDE 68: WATER FILTRATION



Explain that we are now going to look at a way in which physical contaminants are removed from water.

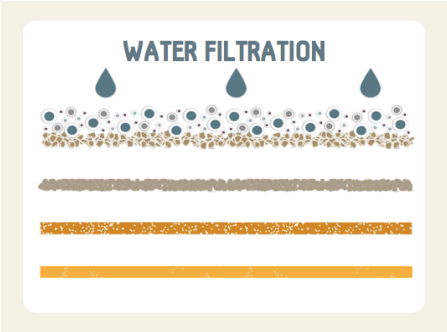
- We're going to look at sand filters. These are one of the most commonly used water treatment technologies in the world. Sand filters removes physical contaminants.

- After looking at the principle of filtration, we are going to build a miniature version of a sand filter.

Refer to the diagram on the slide and explain that a sand filter works by using gravel and sand of different sizes. Refer to the diagram to compare the size of material in each layer. Explain that the layers gradually get smaller.

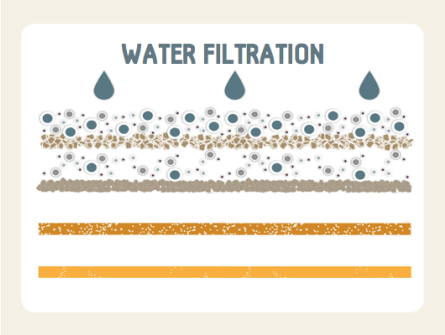
Note: use next slides to go a step by step explanation of how the filter works.

SLIDE 69: WATER FILTRATION



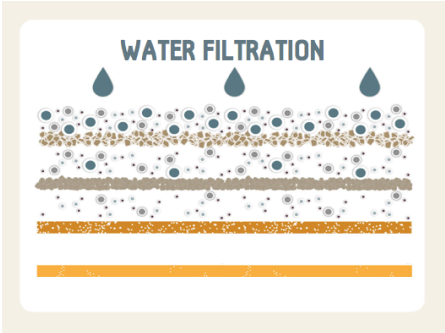
1. Water collected form the water source enters the filter from the top. We know the water is an impure mixture, containing lots of other components than just water molecules.

SLIDE 70: WATER FILTRATION



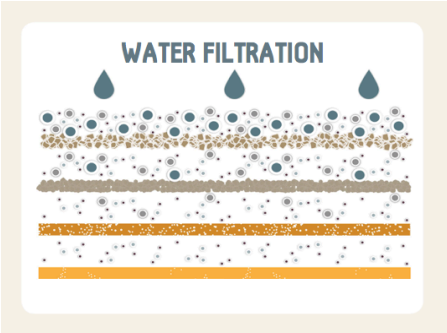
2. When the contaminated water first enters the filter the larger physical contaminants are filtered out first using the larger filtration materials, in this case the larger gravel. Refer to the diagram having fewer large particles once the mixture has passed through the first layer.

SLIDE 71: WATER FILTRATION



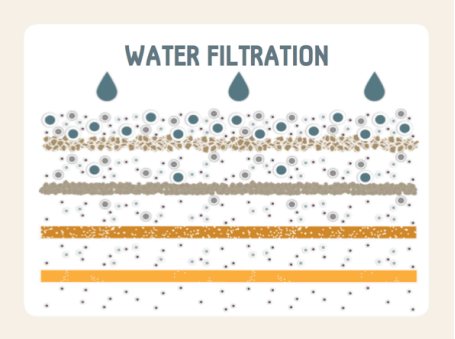
3. As the mixture passes through each stage the next largest particles are filtered out.
If pupils struggle to grasp this use the analogy of a sieve only letting smaller items though leaving the larger ones behind.

SLIDE 72: WATER FILTRATION



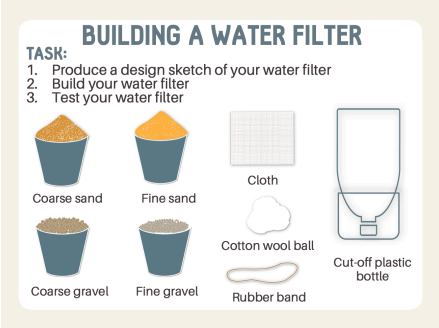
4. Again, only the smallest particles can pass through to the next stage, purifying the mixture even more.

SLIDE 73: WATER FILTRATION



- Explain that we have seen the filter layers gradually get smaller, so that the gaps between the gravel and sand get smaller. This is used to remove the next largest physical contaminants at each stage until most/all the physical contaminants are removed from the water.
- Use the diagram to explain that the reason to graduate the filtration materials from largest to smallest rather than just passing the contaminated water through the smallest filtration material only, is that if you started by sending the contaminated water through the smallest filtration material first, the large contaminants would collect and block up your filter much more quickly.
- Therefore, compared to a filter with graduated layers, over time your filter would stop working much more quickly. The filter would need to be cleaned or replaced more often, which is a tedious and costly job.

SLIDE 74: BUILDING A WATER FILTER



Use this slide to explain the activity to the class. Tell them, that in groups, they will be designing and making a water filter. Explain to the pupils that you will be testing their filters afterwards using contaminated water.

- Each group should have a worksheet to fill in.
- They should first design the filter and fill out their worksheet in their groups, then build it when everyone has finished their sketch. **Don't hand out the building materials until the designs are finished!** This highlights the importance of planning.
- **Note:** Carefully explain the difference in size between the available materials – some of the pupils will not know the meanings of 'coarse' and 'fine'.
- If you are behind schedule, give a strict time limit for planning to ensure adequate building time. Designing generally takes much longer than building. Allow at least 10 minutes for planning and 5 minutes for building.
- During the plan and build task highlight the engineer skills pupils are displaying- planning, creativity, problem solving, teamwork, evaluative.

Signal to the class the end of planning time and start of building time.

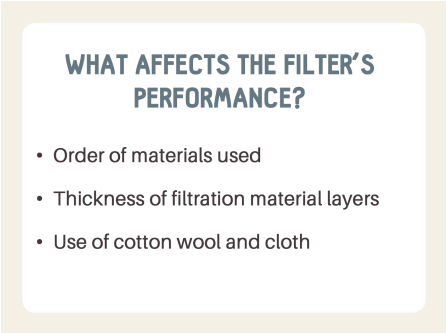
- Each group should have enough of the filtration materials to make their filter. The filtration materials are coarse gravel, fine gravel, coarse sand, fine sand, a piece of cloth (dishcloth), an elastic band and the cotton wool ball – as well as the cut-off water bottle top and bottom.
- The cut edges of the water bottle should be covered by tape (electrical is most effective) to protect the children from the sharp edges.
- Ask them to bring their filters to a table at the front when they are finished, to be tested when everyone is ready.
- Remind the pupils of the filtration principle, however, encourage them to work out what order the materials should go in themselves by thinking about which way the water will flow through the filter.

SLIDE 75: LET'S TEST THEM!

When the time is up, get testing!

- Show pupils the contaminated water and get them to rank the 'dirtiness' of the water, on the back of their sheet in the evaluation section.
- One at a time, pour the contaminated water into the top of the water filter (being careful not to spill any or overfill fill it – if you are worried about making a mess you can put paper towels under the filters) and see what happens.
- Do this for all the water filters to compare their performances.
- As you're going, if any are particularly good, or particularly bad, ask the pupils why they think this might be. Is this because they ordered their materials incorrectly? Is it because they didn't use enough of a particular type of material etc.
- Manage pupils' expectations about the performance of their filters by informing them that in the real world, the water takes a long time to flow through the filtration system so more of the contaminants are removed.
- Explain that this process does not remove chemical contaminants or all biological contaminants, so sand filtration is normally only a part of the entire water treatment process.

SLIDE 76: WHAT AFFECTS THE FILTER'S PERFORMANCE?



You should have discussed some of these things whilst testing the water filters, but use this slide to briefly summarise the factors that affect the filter's performance and conclude the activity:

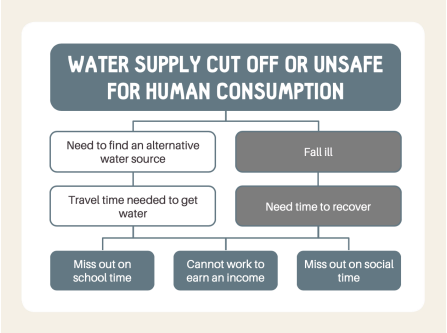
- The order of the filtration materials
- The thickness of the filtration material layers
- Use of cotton wool and cloth (is the cloth doubled over etc.)
- The quality of the filtration materials (were they already dirty themselves)

Highlight that these might be things you would reconsider if you were to do the activity again to improve the filter's performance and optimise the design.

After testing instruct the group to evaluate their water filter's performance on the worksheet if they have not done so already.

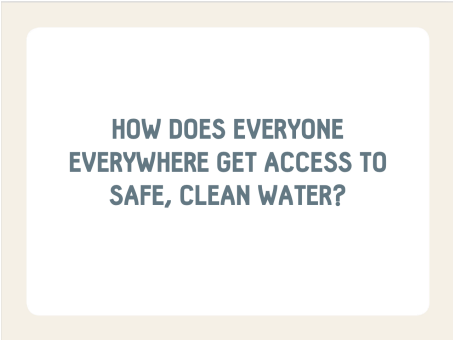
LOOKING AFTER WATER AND WHAT YOU CAN DO

SLIDE 77: REITERATING THE IMPORTANCE OF WATER



- Use this slide to do a quick recap on how vital water is to us, and what can happen when we lack access to safe, clean water.
- Lead into the next slide by concluding that because water is such an important resource for everyone on the planet, but it is difficult to bring it to us where and when we want to use it, it is very important that we look after it, and treat it as the precious resource that it is.
- We should all be careful to conserve water as best we can – e.g. we should not be wasteful with it.

SLIDE 78: HOW DOES EVERYONE EVERYWHERE GET ACCESS TO SAFE, CLEAN WATER?

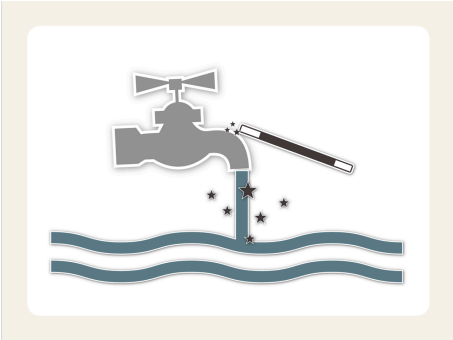


Conclude the first part of the session by summarising the key points culminating in this question:

- Highlight that water, particularly clean water, is essential to human life. But, unfortunately not everyone has equal access to this vital resource.
- All around the world, people are addressing this issue and recently there has been a commitment made amongst global leaders to ensure access to clean safe water for everyone, everywhere by 2030 through The Sustainable Development Goals.

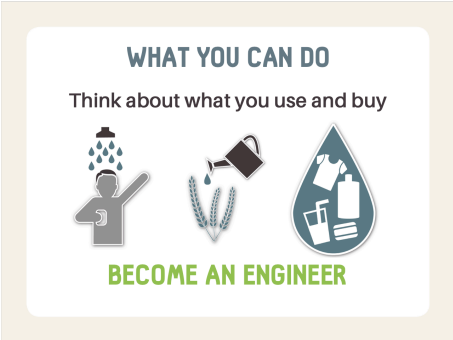
So, we have to ask the question – how can this happen? How does everyone, everywhere get access to clean, safe water?

SLIDE 79: THE MAGIC OF ENGINEERING



- So, we have to ask the question – how can this happen? How does everyone, everywhere get access to clean, safe water?
- This is exactly what being an engineer is all about – finding ingenious ways to address problems so that we can meet our needs – in this case, getting water.
- So, engineers and engineering are part of the answer to the question 'How does everyone, everywhere get access to clean, safe water?'
- Explain that if they become engineers one day, they can help solve the world's problems, and give people all over the world access to clean water.

SLIDE 80: WHAT YOU CAN DO



Use this slide to explain to the class that here are some ideas for how you can individually conserve water.

- This doesn't just mean doing things like turning off the tap when you're not using water, being as quick as you can in the shower, using showers rather than baths as these use less water, only putting your clothes in the washing machine when they are actually dirty and need cleaning, and only using the washing machine or dishwasher when it is full.
- Explain that they need to remember that huge amounts of water are used to produce food, textiles and technology. If they want to conserve water, then it is important to remember the impact of what they eat and buy.

Explain that these are examples of things pupils can do in their everyday lives, but also you hope that the workshop has inspired them to consider how they could play a major role in tackling issues to do with water access, by becoming engineers themselves.

SLIDE 81: WE DON'T JUST USE WATER DIRECTLY

Use this slide to recap the main areas where there are hidden water requirements. Remind them about trying to eat food which requires less water to produce, and only buy the clothes and technology that they really need.

http://www.unesco.org/new/fileadmin/MULTIMEDIA/FIELD/Venice/pdf/special_events/bozza_scheda_DOW04_1.0.pdf

REFLECTIONS ON LEARNING

SLIDE 82: WHAT HAVE WE LEARNED?

Summarise the overall aim of the workshop: to deepen their understanding of what engineers do and the global challenges that engineers are working to address.
To test the knowledge of the class, ask each table, or even more pupils, a question about a topic covered in the workshop, such as:

- What is something we use water for
- What are the consequences if you have to spend time looking for clean water
- Give an example of a water source
- Give an example of a water technology
- What might stop someone having access to clean water
- Give an example of a physical/biological/chemical contaminant
- How can we remove the physical contaminants from water
- How can we conserve water by changing our diet/what we buy, etc.

Pupil feedback is vital to measure the success of the workshop.
Hand out sticky notes and encourage the pupils to fill them out with:
Score of 1-10 for how much they enjoyed the workshop
Something that they enjoyed about the workshop
Something that they did not enjoy about the workshop
Something new that they have learned from the workshop
Take a photograph of the sticky notes, or take them with you, so that you have a record of how well the workshop was received.

SLIDE 83: THANK YOU!

- Thank the class for listening and participating in the workshop.
- Thank the teacher for having you.
- Highlight to the class that if they've enjoyed the process we've gone through today that they might like to find out more about engineering and what engineers do. There are lots of other things that engineers do, not just bringing water for us to use – for example they improve agriculture and manufacturing processes, so that they require less water.

SLIDE 84: QUESTIONS?

What we did today

STEM

QUESTIONS?

University

Engineers Without Borders UK

- Encourage the pupils to ask you about any relevant topic. When talking about your university experience, remember to make it clear that you can only speak for yourself and other people have different answers to you. All ambassadors should answer the questions, to get a better range of answers.
- Clear up, don't leave a mess, and safe travels home!