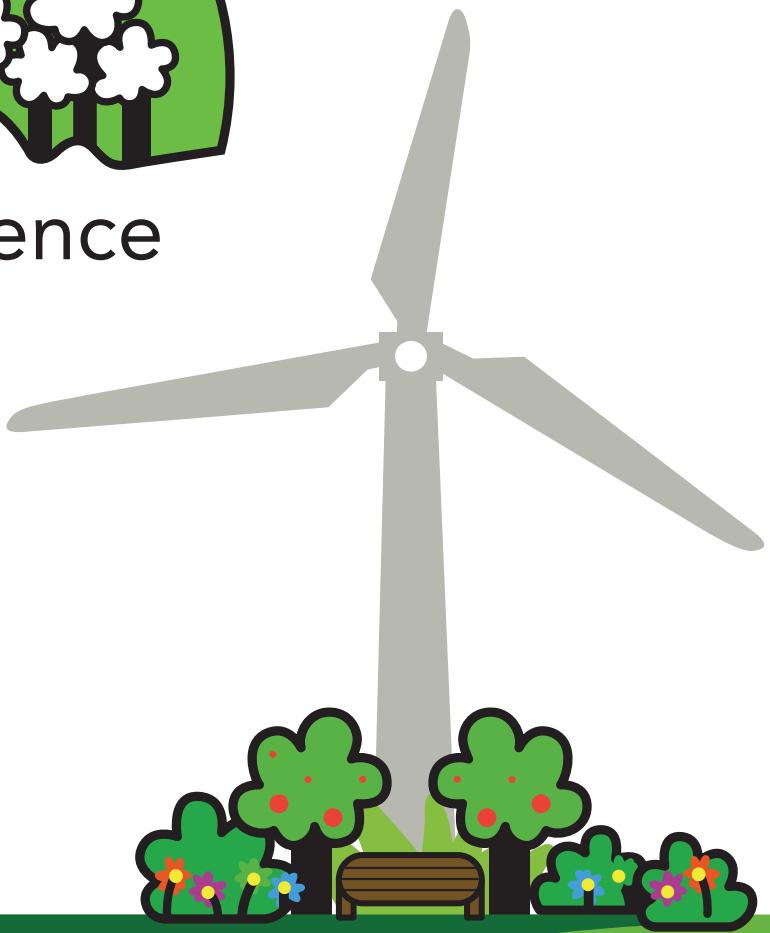
urban science



In The Shade

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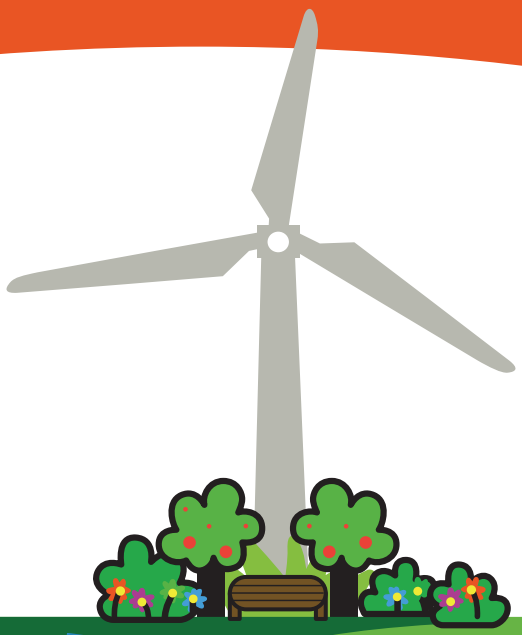

In the Shade

Students investigate the characteristics of UV Light, and explore how their knowledge can be used to create a safer environment for humans.

A curriculum linked learning module for students aged 13-15 to develop competences in working scientifically.

Learning challenge: In the Shade

To tan or not to tan? When you expose bare skin to sunlight, your skin will either burn or tan. UV radiation carries enough energy to break chemical bonds in your skin tissue and with prolonged exposure, your skin may wrinkle or skin cancer may appear.

How can we recognise the harmful effects of solar radiation and take preventative measures to reduce the risks associated with exposure to sunlight?

This learning module can be used flexibly within the curriculum to support key knowledge about physics and develop working scientifically competences. The learning links with the Sustainable Development Goals and provides a broader context for student learning. It is suitable for adapting as a STEM activity or Eco Club.

The topic of UV Light links with climate change through greenhouse gases and CFCs. The topic of CFCs offers links with Ozone and the impact CFC use had in creating the Ozone hole. Finally, links can be made with the electromagnetic spectrum which includes an understanding of UV light.

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To deliver this module we recommend:

- Start with one or both of the Stage 1 activities to elicit current student understanding. Start a messy wall to record student work throughout.
- You might also like to start with a short version of Stage 3, asking students to use the UV beads to see how they react and carry out some quick experiments; this will prepare them to design a more rigorous experiment in Stage 3.
- Use the Stage 2 activities to introduce the context for the Stage 3 challenge.
- Stage 3 is the practical challenge where students gather data and make conclusions.
- In Stage 4 you will provide suggestions for sharing and presenting results.

Subject

Biology	Chemistry	Physics	Raising Attainment
		✓	✓

Programme of Study reference

• Physics	**Wave motion** • uses in the radio, microwave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions, hazardous effects on bodily tissues. In the Shade explores the health impacts of over-exposure the UV light and how we can use scientific understanding to design safe places to recreate outside.	• Working scientifically	Students successfully completing this module will have had the opportunity to access these statements: 1d.1f,2a,2b,2d,2e,2f,2g.3ai,3av3avi,3b,4a,4b, Some will also have completed the following: 1c,1e, 2c. See Annex 1 for full statements.

Sustainable Development Goals

All Urban science modules try to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' and in addition focus on education for sustainable development and global education - SDG 4.7. Support and resources here:

http://www.teachsdgs.org/

In the Shade particularly supports SDG 11 'Make cities and human settlements inclusive, safe resilient and sustainable'. By completing this module, which culminates in their designing a sustainable safe and resilient school café, you will have contributed towards an understanding of this goal. Other resources can be found here:

http://worldslargestlesson.globalgoals.org/global-goals/sustainable-cities-and-communities/.

In addition, this module also contributes towards SDG 3 'Ensure healthy lives and promote well-being for all at all ages.

http://worldslargestlesson.globalgoals.org/global-goals/good-health/

Activities Overview

Stage 1	Time (mins)	Resources needed
Data Race	25 mins	Student Sheet 1
Future Forecasts…what it?	20 mins	None required

Stage 2	Time (mins)	Resources needed
Measuring UV Light	20 mins	UV beads, UV lamp
For and Against (and in between)	25 mins	None, but make sure you have agreed the area of your café, seating area, etc
Filter and Focus	30 mins	Print reading resource in advance

Stage 3	Time (mins)	Resources needed
UV Research Project	50 mins (can extend to two lessons)	UV beads, fluorescent light, suitable outdoor area, selection of materials to test UV protection such as sunscreen, zip-lock bag, piece of glass (or a window), sunglasses, regular glasses, black t-shirt, white t-shirt, wide-brimmed hat, etc. Student Sheet 2 and 3.

Stage 4	Time (mins)	Resources needed
Presenting Results and Peer Assessment	50 mins (can extend to two lessons)	Student Sheet 4

Health and Safety: please refer to the guidance provided on the Urban Science website before commencing the module.

www.urbanscience.eu/uk/learning-modules/health-and-safety/

STAGE 1 - In the Shade

Inquiry based learning stage

Stage 1 - Initiating and eliciting	✓	**Stage 2 - Defining and responding**	
Stage 3 - Doing and making		**Stage 4 - Communicating, presenting and evaluating**	

Learning objectives

1. Students reveal their knowledge on the topic of ultraviolet light.
2. Students are able to find out information relevant to the topic.
3. Students can make predictions about their future.

Learning outcomes

1. Students discuss key scientific facts about ultraviolet light and the effects on society.
2. Students demonstrate the ability to quickly find out relevant knowledge.
3. Students debate how the future might change and the impacts this will have.

Overview of lesson

This lesson finds out what students already know about ultraviolet light and encourages them to extend this knowledge. It asks students to consider the positive and negative consequences of ultraviolet light.

Lesson structure

Main 1: Data Race

This activity involves students finding quick answers to questions they may have.

The teacher sets students off on a 'race' to find out key bits of information on the topic of ultraviolet light. The teacher may suggest sources, or allow students to choose how to find the information. A suitable time limit can be set.

The activity is a quick way of gathering and sharing information about the topic. It can lead to discussions about the nature of information and data sources, and the teacher can raise questions about the accuracy and sources of the information, and suggest other ways of approaching the topic. This can be a useful mechanism for ascertaining the level of knowledge on a particular topic. It is also a good and efficient mechanism for getting students to find knowledge in a short period of time.

Two website references are provided in Student Sheet 1 to assist students in finding information. We suggest using these sites; general web searches are less helpful.

Sample questions:

- Find five different uses for ultraviolet light.
- List different types of wave; order them from long to short wavelength.
- Provide two examples of how electromagnetic waves transfer energy.
- Search three reasons overexposure to ultraviolet rays can be harmful to humans.
- Explain how most ultraviolet light is filtered by the earth's atmosphere.
- See Student Sheet 1 for more, including suggested answers.

Main 2: Future forecasts…what if?

The teacher encourages students to produce 'scenarios' that predict how social or technological trends might influence people's behaviour in the future or what greater effect they might have on society. For example:

- What if…climate change increased ultraviolet light exposure?
- What if…microwaves were found to be harmful?
- What if…we do not receive enough sunlight (health effects)?

This activity allows students to explore open-ended questions and compare desirable, probable and possible futures. The forecasts may be used as a basis for research into actual predictions and to likely changes.

As an additional resource, the following video provides a helpful introduction You might wish to start with the video ahead of the 'Future forecasts…what if?' activity. This has a young person's perspective. A 'celebrity' describes how UV light can have a detrimental impact on their health, particularly by increasing their risk of skin cancer. It is part of a wider package that links to a Personal Health and Social Education (PHSE) package.

https://www.teenagecancertrust.org/about-us/what-we-do/education-awareness-resources/shunburn

Plenary: The messy wall

Create a messy wall (sometimes referred to as a working wall) where the student ideas and questions can be displayed alongside the key scientific concepts. Be sure to update your messy wall regularly throughout the module.

Student Sheet 1

Data Race. Use these websites

https://www.bbc.com/bitesize/guides/z432pv4/revision/1

https://www.peep.ac.uk/content/1300.0.html

Q1. What is Ultraviolet radiation? (UV)	Electromagnetic radiation with a wavelength shorter than visible light. It is harmful to humans and causes sun burn which can lead to skin cancer.
Q2. What is the Ozone layer?	A layer of gas in the atmosphere (in a part called the stratosphere) that protects the Earth from harmful ultraviolet (UV) radiation from the Sun. This gas 'Ozone' O_3 - is made up of molecules of three oxygen atoms together.
Q3. How are UV rays linked to the Ozone layer?	As particles of UV light strike a molecule of ozone, it absorbs it, breaking it down into oxygen again. This stops the UV rays from getting through to the surface of the earth.
Q4. What are chlorofluorocarbon (CFCs) gases? What do they do? Where do we find them?	These gases have been responsible for 'depleting' the ozone layer as they attack and destroy ozone molecules. CFCs have been used in aerosols, (eg hairspray cans), fridges, and in making foam plastics.
Q5. What is the hole in the Ozone layer? What are we doing about it?	These are holes caused by a decrease in the ozone layer and found over polar regions. They let harmful ultra-violet radiation in. CFCs were banned in many countries in the mid-1990s after it was found that they were breaking up the Earth's ozone. Some scientists say the hole in the ozone layer over Antarctica could disappear within 50 years.
Q6. How does this issue link to climate change?	CFC's are also powerful greenhouse gases and are adding to the 'Greenhouse effect'.

STAGE 2 - In the Shade

Inquiry based learning stage

Stage 1 - Initiating and eliciting		**Stage 2 - Defining and responding**	✓
Stage 3 - Doing and making		**Stage 4 - Communicating, presenting and evaluating**	

Learning objectives

1. Students investigate and differentiate between different effects of UV light.
2. Students are able to make reasoned judgements.
3. Students are able to find out information relevant to the topic.

Learning outcomes

1. Students discuss different views and opinions, and reach conclusions.
2. Students identify and list positive and negative consequences.
3. Students debate which issues are more important to consider.

Overview of lesson

Start by introducing the theme: a new café will be opening near to (or in) the school with a large outdoor seating area. The owners want the outdoor area to attract young people. The owners are keen their café provides a healthy diet and environment for customers. Alternatively, you might like to substitute the café for an actual outdoor seating area in your school; this will make the practical work more real for your students and might also lead to practical action based on the results of your Stage 3 experiments.

Lesson structure

Introduction

Start by introducing the theme: a new café will be opening near to (or in) the school with a large outdoor seating area. The owners want the outdoor area to attract young people. The owners are keen their café provides a healthy diet and environment for customers. You might wish to provide an actual location for the café or indicate a local high street where the café is to be situated.

Main 1: Measuring UV Light

UV beads are a simple tool for measuring UV intensity over time. They contain a chemical that changes colour when exposed to UV radiation. The more UV there is, the darker the beads become.

Introduce your students to the UV beads. A good way is to provide each student with 4-5 beads with their hands closed (no looking); then ask them to go to a window, open their hands and see what happens (the beads change colour). Why is this?

Try a few different parts of the classroom and observe the change in the beads. If you have a UV lamp set this up to show how the beads are reacting to UV light levels. Ask students to think about how they would measure and record results using the UV beads to compare different locations. Finish this introduction to the beads by explaining they will use them to assess the safety of the new café outdoor seating area (or suitable areas in your school) later. You might ask them to think now about how they will measure and record change.

Main 2: For and against (and in between)

This is a simple technique that encourages students to map out all the different sides of an argument before seeking to identify their own position. Just as important is to encourage students to go beyond the 'black and white' and recognise the grey areas in between. More refined approaches can begin to examine the categories themselves and see whether they represent an adequate view of the theme or issue.

1. Once the location for has been revealed, ask students working in groups to list positive and negative aspects for the café e.g. will it provide a space for meeting friends, create traffic hazards with more people, etc. Also ask them to list any issues they are unsure about.
2. When ready, groups take it in turn adding their issues to the board.
3. Encourage students to discuss which are the most important issues that need to be considered.

Main 3: Filter for focus

What factors will be important when considering the outdoor seating area in terms of health for the customers? This activity builds on 'For and Against' by exploring the science issues identified, UV light in our example.

In pairs or groups students work together to agree the top five most important words in a piece of text, sections on a web page, sub-themes of a topic, and so on. When ready each group takes it in turns to write their key items on the board. Other groups do the same, but can only add words that are not already there. The activity encourages students to focus on the most important aspects of a topic. When working well, it can help students to clarify their understanding of the essential features of a theme or issue.

Text example - https://earthobservatory.nasa.gov/Features/UVB

Students could continue with a priority mapping exercise to investigate which are the most critical issues and who needs to be involved to solve them.

STAGE 3 - In the Shade

Inquiry based learning stage

Stage 1 - Initiating and eliciting		**Stage 2 - Defining and responding**	
Stage 3 - Doing and making	✓	**Stage 4 - Communicating, presenting and evaluating**	

Learning objectives

1. Students are able to plan and carry out an investigation.
2. Students are able to reach reasoned conclusions.

Learning outcomes

1. Students explain that UV rays come from the sun and can cause sunburn.
2. Students demonstrate through the use of UV beads that various objects block UV rays either partially or completely.
3. Students present recommendations for reducing harmful effects of UV light.

Overview of lesson

In this lesson students carry out an outdoor investigation into the effects of UV light; based on their research results they make recommendations for establishing a safe outdoor seating area for the café. The example of a café is provided here, however, the investigation will work best if you can find a real-life example in your school grounds, for example an outdoor seating area.

If your school has a UV meter this could be used to compare different ways of data collection and consideration of accuracy of measurements.

Lesson structure

Introduction

Now that students have explored more about the new café, introduce the need to consider the health of customers using the outdoor seating area. Make links with the previous lessons where students have highlighted UV light as an issue.

The activity is inspired and based on an activity developed by the "Science Learning Hub – Pokapū Akoranga Pūtaiao, University of Waikato" who have created a range of resources exploring UV light. You can read the original lesson activity here:

www.sciencelearn.org.nz/resources/1340-investigating-uv-intensity.

Main: UV Research Project

The Sun gives off different kinds of energy including visible light, infrared, ultraviolet light, radio waves, microwaves, X-rays and gamma rays. Your skin is an excellent detector of UV, it can turn either red (a sunburn) and/or brown (a suntan) when exposed to UV. A better and safer way to detect UV light is to use the UV beads introduced in Stage 2 above.

For this activity, it is preferable to use beads of one colour only so the colour changes and comparisons are more obvious. Keep the beads in a closed opaque container to prevent UV rays from striking the beads prior to the activity.

Explain that they will be testing the UV beads in a range of environments, and that based on their results they will make recommendations for the café's outdoor seating area.

What you need

- UV beads - these can be easily purchased online
- An area where your café / outdoor seating area is to be located
- Sunscreen
- Zip-lock bag
- Piece of glass (or a window)
- Sunglasses
- Regular glasses
- Black t-shirt
- White t-shirt
- Wide-brimmed hat

What to do

Have students predict/talk about the following:

- Where do you think the beads will turn the darkest?
- What do you think happens to UV levels on a cloudy day?
- Is the shade really free of UV?
- How well will sunglasses and regular glasses protect the beads, and therefore your eyes, from UV?
- Can you get sunburnt sitting next to the window inside a car or building?
- How well does sunscreen protect us from UV?
- Which kind of clothing or canopy gives us the best protection from UV?

To carry out their investigations, students will need to visit the proposed area for the café and compare UV light in different areas and under different condition e.g. full sun, shade, someone wearing sunglasses, etc.

Students should already have thought about what they are going to measure and how to record changes in the UV beads (see Stage 2). If you have used the beads in the classroom, you will observe that they change colour quickly. If necessary, ask students how they are going to measure colour change so they can compare UV light between different areas (Hint: a timer and a video of the colour change works well).

Continued on page 11...

Lesson structure *(continued)*

Some tests students might devise are:

1. Take the UV beads to a shady spot outside.
   - Do any beads change colour?
   - Is there UV radiation in the shade?
2. Now place the beads in direct sunlight.
   - What do you notice about the intensity of the beads' colour?
3. Place 2–3 beads beneath the glass of a pair of regular prescription glasses and place a second set of 2–3 beads beneath the glass of a pair of sunglasses. Place a third set of 2–3 beads alongside but not beneath any glass.
4. Place 2–3 beads in a zip-lock bag containing a little sunscreen. Close the bag and shake to coat with sunscreen. Make sure the beads are thoroughly coated. Leave the bag in full Sun for 50 minutes. Check the beads every 5 minutes.
5. Place 2–3 beads beneath a single layer of a dark coloured t-shirt and another 2–3 beads beneath a single layer of a white t-shirt. Leave in full sunlight. Check the beads at 5-minute intervals.
   - Is there a difference between the colour changes of the beads beneath the two shirts?
   - Which shirt would provide you with better sun protection?
   - What material would be best for a sun shade?
6. We assume that wide-brimmed hats give protection from UV. On a sunny day, preferably with cumulus clouds, have students attach a UV bead as an earring, wear a wide-brimmed hat and ask a partner to observe any colour change of the bead.
   - How can you explain your findings?
   - What does this indicate about reflecting of UV light?
   - How could you relate this to a sport such as skiing?

(Explanation: the beads will still change colour – though to a lesser extent – due to the scattering of UV, particularly by cumulus clouds, and the reflecting of UV light from ground surfaces.)

Plenary

Ask students to present their results by creating a table to record their findings. Based on the results, ask students to list criteria for creating a safe outdoor seating area for café customers and then make a recommendation, justifying their conclusions against their research. Students may wish to consider what the customer would like to have in an outdoor seating area, contrasting this with the potential risks from UV light and mitigation measures.

Take the discussion further to link with broader sustainability issues. Using the table in Student Sheet 2, consider the consequences of increased UV radiation on cities and urban design. With increased levels of UV radiation how can we design cities to reduce exposure and reduce ozone depletion? Use the table in Student Sheet 3 to consider different future scenarios (probable if we do nothing / possible if we make some changes / preferable if we make significant change).

Once students have conducted their investigation with a real example within your school or local community, you could apply the same thinking to designing a new outdoor seating area. Using their new knowledge about UV Light, ask how it can be designed, what materials should be used, etc. Further considerations could be included, for example, if seating area is to be covered can this be used to site photovoltaic cells to power mobile phones?

Homework

The discussion in the plenary naturally leads to a consideration of SDG 11 'Make cities and human settlements inclusive, safe resilient and sustainable'. There are further resources here:

http://cdn.worldslargestlesson.globalgoals.org/2015/09/GettyImages-569929489-insta.jpg.

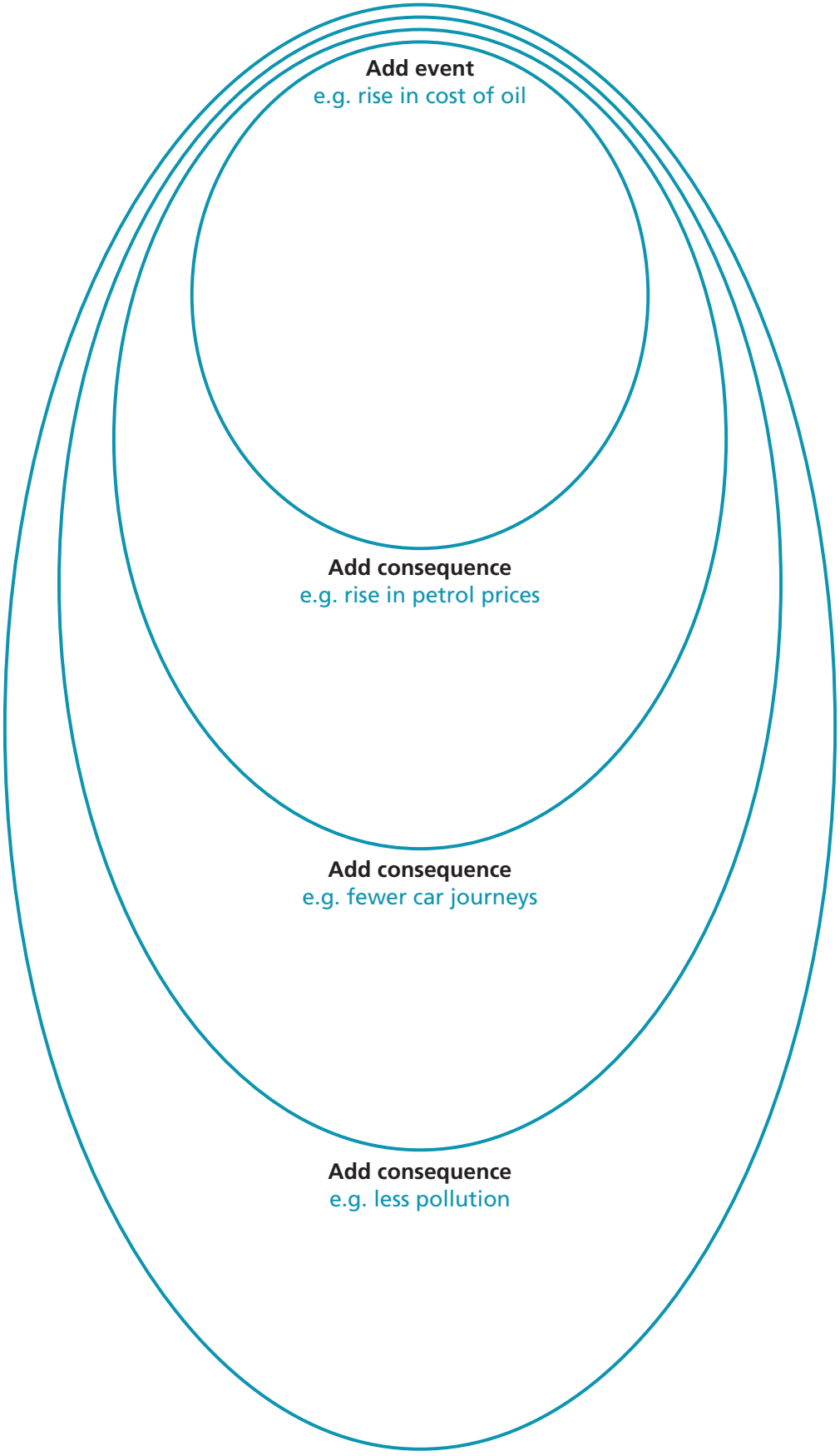
Their task is to consider some questions in readiness for preparing their presentations next session and to ensure that they have a broad 'global outlook'.

- How is your café 'safe resilient and sustainable'?
- Can you find examples from cities around the world?

Student Sheet 2

Futures wheel

Think through the consequences and impacts of an event? What are the knock on effects?



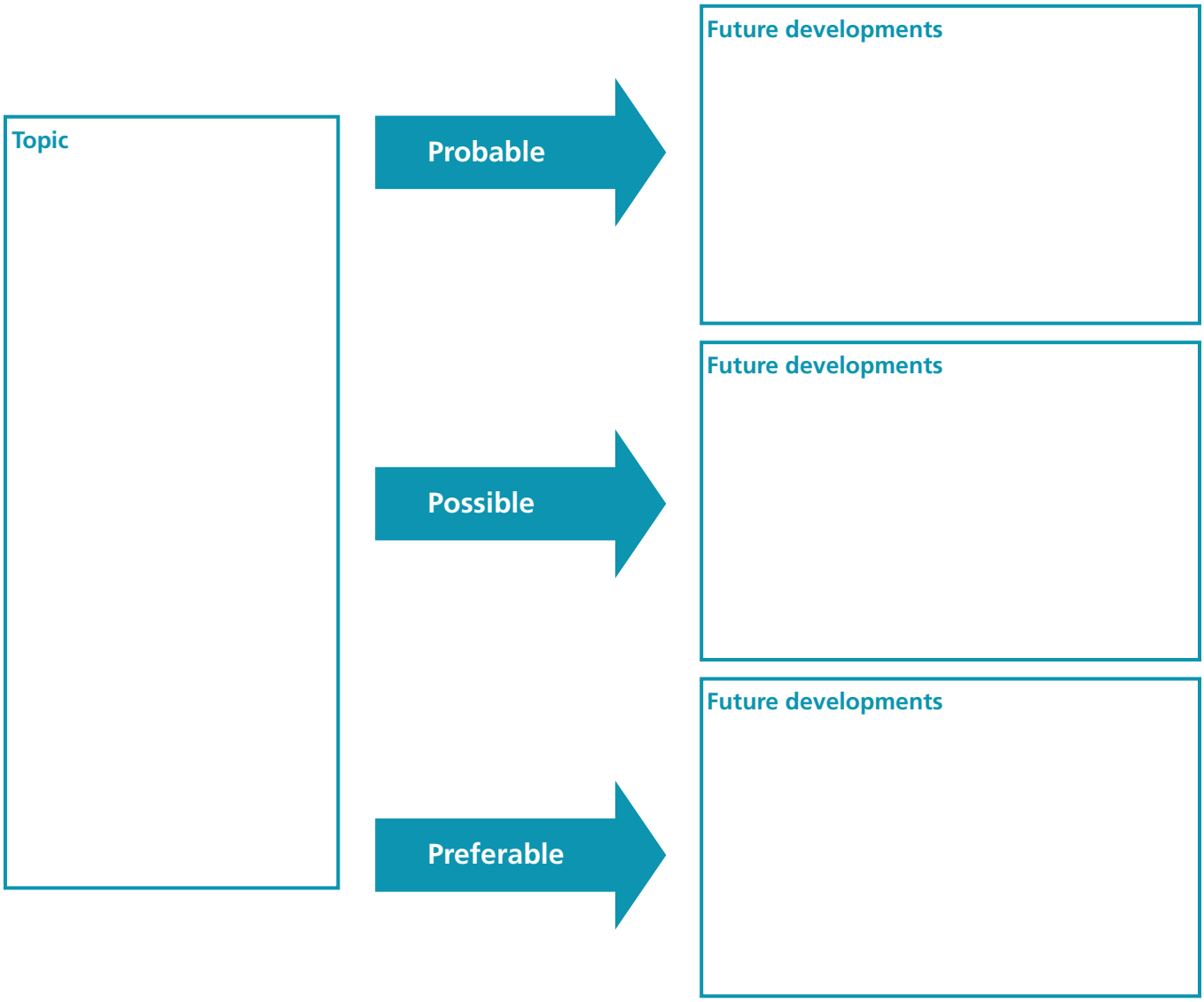
Student Sheet 3

Possible/probable/preferable futures

Think about the way in which a particular theme or issue may develop in the future.

Student name: .....

Topic: .....



STAGE 4 - In the Shade

Inquiry based learning stage

Stage 1 - Initiating and eliciting		**Stage 2 - Defining and responding**	
Stage 3 - Doing and making		**Stage 4 - Communicating, presenting and evaluating**	✓

Learning objectives

1. Students are able to communicate their results.
2. Students can apply a range of communication techniques.

Learning outcomes

1. Students select an appropriate communication technique.
2. Students present their results using their chosen technique.
3. Students critique the work of others.

Overview of lesson

In this lesson students think about how to communicate their results. They consider a range of options and then select the most appropriate. After communicating their own results, they listen to and provide constructive feedback to other groups.

Lesson structure

Introduction

Now that students have developed their results, they need to provide feedback to the café owners. To make this as realistic as possible you might have based your project work on a real local café or used the school canteen. Invite the café owners or school canteen staff to the presentations.

Main

Students consider how to present their results. This is a generic list of ways students can consider.

- **Poster** - create a poster communicating your results and making recommendations for the café; the poster could include a picture of the café based on your recommendations.
- **Film** - create a 5-minute film communicating to the café owners how you carried out your research and the results; you could include interviews with potential customers.
- **Presentation** - deliver a 5-minute presentation for the café owners.
- **Report** - write a report laying out your recommendations and evidence.
- **Other** - add your own suggestion.

Once students have prepared their presentations, they are presented to the café owners or school canteen staff. They (and students) are invited to present feedback using the form in Student Sheet 4.

Plenary

Ask students to share their reviews of each presentation. Groups can review their work and consider ways to improve it in the future.

Student Sheet 4 - Review form

Review plans

This activity can be used to analyse or appraise anything in a structured way.

Student name: .....

Topic: .....

Strengths

Weaknesses

Enablers

Barriers

Opportunities

Threats

Annex 1 - Key Stage 4 Working Scientifically Statements

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

1. **The development of scientific thinking**
    a. the ways in which scientific methods and theories develop over time.
    b. using a variety of concepts and models to develop scientific explanations and understanding.
    c. appreciating the power and limitations of science and considering ethical issues which may arise.
    d. explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments.
    e. evaluating risks both in practical science and the wider societal context, including perception of risk.
    f. recognising the importance of peer review of results and of communication of results to a range of audiences.

2. **Experimental skills and strategies**
    a. using scientific theories and explanations to develop hypotheses.
    b. planning experiments to make observations, test hypotheses or explore phenomena.
    c. applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments.
    d. carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.
    e. recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative.
    f. making and recording observations and measurements using a range of apparatus and methods.
    g. evaluating methods and suggesting possible improvements and further investigations.

3. **Analysis and evaluation**
    a. applying the cycle of collecting, presenting and analysing data, including:
        i. presenting observations and other data using appropriate methods.
        ii. translating data from one form to another.
        iii. carrying out and representing mathematical and statistical analysis.
        iv. representing distributions of results and making estimations of uncertainty.
        v. interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions.
        vi. presenting reasoned explanations, including relating data to hypotheses.
        vii. being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.
    b. communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations.

4. **Vocabulary, units, symbols and nomenclature**
    a. developing their use of scientific vocabulary and nomenclature.
    b. recognising the importance of scientific quantities and understanding how they are determined.
    c. using SI units and IUPAC chemical nomenclature unless inappropriate.
    d. using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano).
    e. interconverting units.
    f. using an appropriate number of significant figures in calculations.