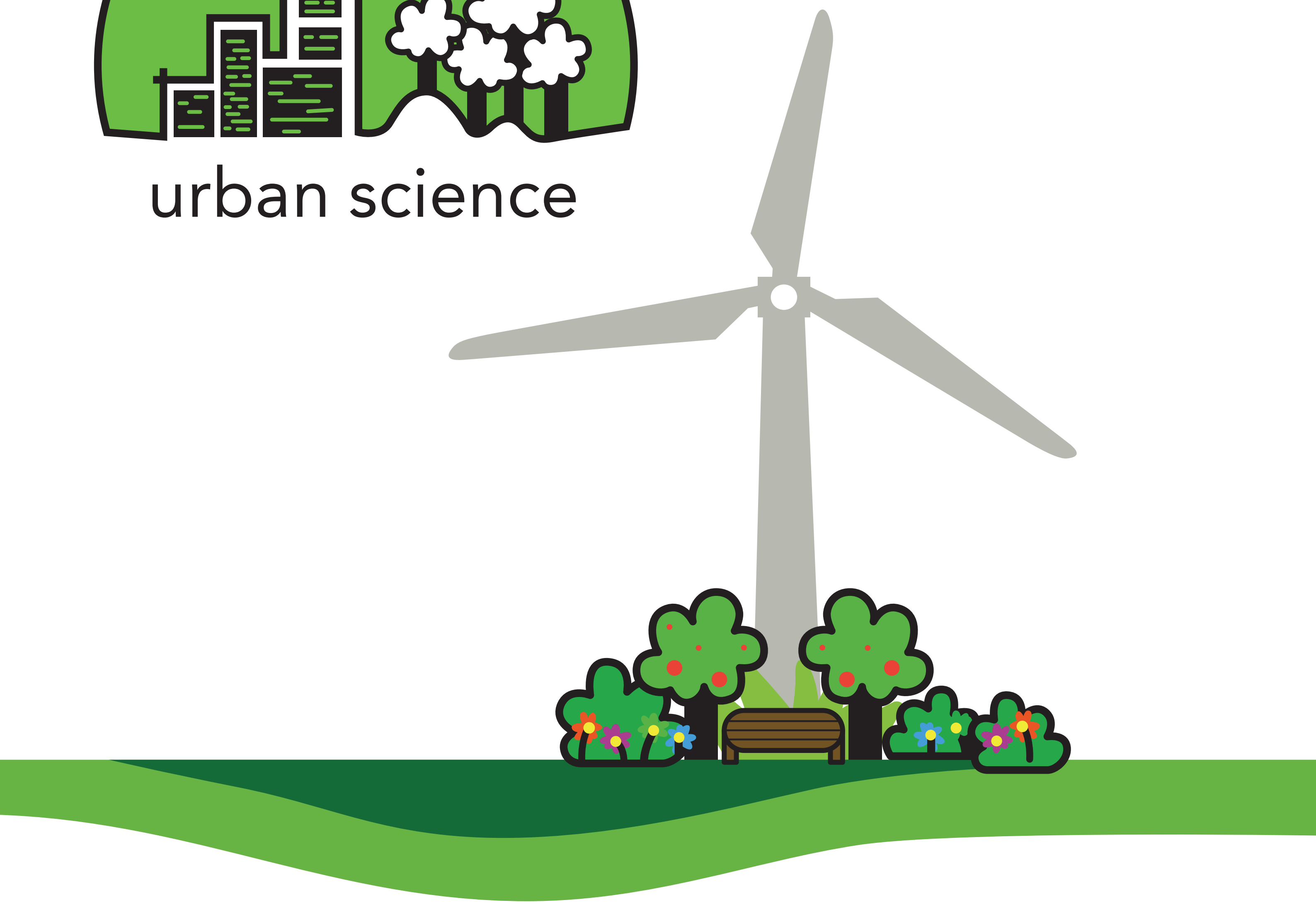
urban science



Grow Wild

www.urbanscience.eu

Co-funded by the Erasmus+ Programme of the European Union

urban science

Grow Wild

Students investigate issues surrounding biodiversity and relate this to their school grounds by finding out information on the flora that exist there. They link their results to the function insects provide as pollinators of food crops and relate how we can support this vital ecological function.

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

Learning challenge: **Can we grow our own food?**

Traditionally cities grew a large proportion of their food within city limits. Now most is grown outside cities increasing environmental impact and reducing green areas. In this challenge students will survey their school grounds and find information on the flora that exists there. They will then look at ideas to address the issues they find, for example an inquiry question could be:

'What seeds will the eco team need to put on their seed papers to improve biodiversity for pollinators?'

These could then be sown in the school grounds and the surroundings in order to make a proposed school fruit and vegetable garden more productive.

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

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To deliver this module we recommend:

- Start with the Stage 1 activity to elicit current student understanding. Start a messy wall to record student work throughout.
- 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

• Biology	**Ecosystems** • levels of organisation within an ecosystem. • some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community. • organisms are interdependent and are adapted to their environment. • the importance of biodiversity. • methods of identifying species and measuring distribution, frequency and abundance of species within a habitat. • positive and negative human interactions with ecosystems.	• Working scientifically	Students successfully completing this module will have had the opportunity to access these statements: 1d,1f,2a,2b,2c,2d,2e,3ai,3aiii,3aiv, 3av,3avi,3avii, 3b,4a,4b. Some will also have completed the following: 1c,1e,2f,2g. See Annex 1 for full statements. Students will also be able to fulfil the requirements for the biodiversity 'Required Practical' as outlined in the three English exam boards. **OCR** https://qualifications.pearson.com/content/dam/pdf/GCSE/Science/2016/teaching-and-learning-materials/GCSE-9-1-Sciences-core-practical-guide.pdf p48 **Edexcel** https://www.ocr.org.uk/Images/234595-specification-accredited-gcse-twenty-first-century-science-suite-biology-b-j257.pdf p57 **AQA** https://filestore.aqa.org.uk/resources/science/AQA-8464-8465-PRACTICALS-HB.PDF p21

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/

Grow Wild particularly supports SDG 15 Life on Land 'Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.' By completing this module, which engages the students in an analysis of the biodiversity of their school grounds, you will have contributed towards an understanding of this goal. Other resources can be found here:

http://worldslargestlesson.globalgoals.org/global-goals/life-on-land/

Activities Overview

Stage 1	Time (mins)	Resources needed
Ask an Expert	25 mins	None required

Stage 2	Time (mins)	Resources needed
Defining Biodiversity Terms	20 mins	Student Sheet 1
Socratic Questioning	25 mins	Teacher Sheet 1

Stage 3	Time (mins)	Resources needed
Surveying the School Grounds	50 mins (can extend to two lessons)	Quadrats, tape measures (10 metre), identification keys, recording sheets.

Stage 4	Time (mins)	Resources needed
Presenting Results and Peer Assessment	50 mins (can extend to two lessons)	Student Sheet 2

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/

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 understand that they have 'something interesting to say' about the topic of biodiversity and are listened to.
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 the key scientific facts about biodiversity and growing food.
2. Students demonstrate an awareness of the key opposing arguments regarding smaller scale local growing systems and larger scale agricultural schemes.
3. Students can state how growing food is linked to biodiversity.
4. Students understand the cyclic nature of biodiversity.

Overview of lesson

In this session students will interrogate an 'expert' or a series of experts on the topic of biodiversity in cities. This will involve facilitation by the teacher.

Lesson structure

Introduction

As students will be investigating issues surrounding biodiversity and how this relates to their school grounds, we recommend starting with an inspirational video on this topic. Here are some good examples.

Grow cycle - A company that grows oyster mushrooms from coffee grounds and then sells them back to the cafes. This is a BBC 'One Show' video of the project:

https://grocycle.com/growing-mushrooms-in-coffee-grounds/?wvideo=exdwtv3rw9

A Ted Talk that discusses why bees are disappearing

https://www.ted.com/talks/marla_spivak_why_bees_are_disappearing?utm_source=tedcomshare&utm_medium=email&utm_campaign=tedspread

How planting trees affects climate change:

https://www.quantamagazine.org/forests-emerge-as-a-major-overlooked-climate-factor-20181009/

David Attenborough looks at the importance of school grounds. It could be used with students or staff:

https://www.youtube.com/watch?v=ImZhcNIL07s

A useful film from America produced by a student on how they created an edible school yard:

https://vimeo.com/178389706

Main 1: Ask an Expert

The following technique allows students to explore the knowledge that exists and is available within their school community.

Each 'expert' from a range (see below) will put on the 'mantle of the expert' and describe what they know. This works best if there are 'props' e.g. a special chair / a wizard's cloak / graduation garment.

- The class can ask questions.
- The expert has the right to say 'pass'.

The teacher can add comments if needed but it is important that the focus is 'what they know'.

Move on to another 'expert' by stating 'who can add to this knowledge'.

Whilst in process it will be useful for the teacher to make a note of any misconceptions.

Also, it is a good idea to appoint a 'group secretary' who will document the key questions and answers. The unanswered questions can be noted on flip chart paper.

Experts

- Primary school students who have been in an eco-club with knowledge of growing in schools.
- Science engineering ambassadors.

  https://www.stem.org.uk/stem-ambassadors.

- NUS – students will give talks on their innovative campus food programmes.

  https://sustainability.unioncloud.org/student-eats/our-bright-future/student-food-enterprises.

- Students /members of the school community.

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.

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 use their learning about biodiversity to start their investigation planning on this theme.
2. Students are able to critically analyse their own and their peer's investigation plans.

Learning outcomes

1. Students check their understanding of the key scientific facts about biodiversity and growing food.
2. Students use Socratic questioning as a technique to analyse their own and their peer's investigation plans.

Overview of lesson

In this lesson students have the opportunity to pull together their ideas about biodiversity in cities and whether they can grow food effectively. It starts with a card sort activity which has been carefully written to focus on understanding of this important concept. They will need a full understanding of this as they move onto 'Stage 3' where they will be looking at the biodiversity of their school and how it can be improved for food growing by:

- Undertaking a given inquiry (perhaps based on a required practical activity);
- Choosing from a given range of inquiry questions; or
- Defining their own questions guided by their teacher.

Lesson in detail

Planning to investigate our school grounds. Can we grow sustainable food in our 'future' city?

Lesson structure

Introduction

Summarise and refer back to the previous 'ask an expert' activity. Use this as the basis to develop student knowledge about biodiversity further with the activities below which build up to the investigation in Stage 3.

Main 1: Defining Biodiversity Terms

In this task students will clarify key biodiversity terms. Provide students with the cards (Student Sheet 1) and ask them to sort the cards based on the questions below. As they carry out each sort, they should write the names of new categories or relationships on blank cards to be added to the cards. For example:

1. 'which are the most important for growing food?
2. 'which ones don't I understand?'

These ideas have been sourced from this website:

http://www.theteachertoolkit.com/index.php/tool/card-sort but there are many variations.

It is a good idea to come back to this exercise as students learn more about the topic. For example, they should have a smaller pile which they do not understand as they make progress.

Main 2: Socratic questioning

Students then think about ideas for their upcoming investigations. Socratic questioning is a mechanism for testing these ideas. This technique can be used for teacher led discussions or it can be used by students in small groups. Even if, as is likely in this module the students will be taking part in one whole class investigation, it will help them to clarify their ideas. They will clarify why they are doing it and address misconceptions. They will analyse and evaluate topics at a far deeper level than 'normal' questioning.

The questions will clarify, challenge and look at:

- Evidence;
- Alternatives;
- Consequences; and
- Question the question.

We have produced a generic guide in Teacher Sheet 1.

Plenary:

Students complete a 'plenary pyramid' and add to their messy wall ideas. List 3 things you learnt today, 2 things you are unsure about and 1 question you would like to ask. Some may reflect again on their biodiversity card sort.

Student Sheet 1

Biodiversity is the variability among living organisms from all sources including on land, the sea, and other aquatic ecosystems; this includes diversity within species, between species, and of ecosystems.	Biodiversity forms the foundation of the vast array of ecosystem services (the benefits people obtain from ecosystems) that critically contribute to human well-being.	Ecosystem services are the basis of biodiversity and: • aid the provision of our food and water; • regulate flooding and disease control; • enrich us culturally, spiritually and recreationally; and • allows for nutrient cycling that maintain the conditions for life on Earth.
Biodiversity is important in human-managed as well as natural ecosystems.	Decisions humans make that influence biodiversity affect the well-being of ourselves and others.	Biodiversity is difficult to measure precisely but it is important to understand how it is changing over space and time, and the things that are driving this change.
Ecological indicators are scientific concepts that measure aspects of biodiversity, ecosystems or drivers of change. No single ecological indicator captures all the dimensions of biodiversity. An example of an indicator is 'the global mean temperature and atmospheric CO_2 concentrations'. These are widely accepted as measures of human effects on the global climate.	Biodiversity can be enriched when designing and constructing new buildings, or adapting existing ones. For instance, having a 'green roof' on your school provides a home for plants and insects. These then provide vital food for other wildlife that can also use school buildings to nest and live (especially if specific spaces are built-in), including rare and threatened species of bats and birds.	The processes underlying the changes in biodiversity are cyclical and its impacts are interconnected between species, habitats, and people.

Teacher Sheet 1 - Socratic Questioning

Clarification of the key concept	Could you explain that answer further? What led you to that judgement? Why did you come to that conclusion? What made you say that?'
Challenging	Is there another point of view? Does this always happen?
Arguments based on evidence	What evidence do you have to support that view? Is there any other information that would help support this? Can we challenge that evidence?
Looking at alternatives	Did anyone look at this from a different angle/ perspective? Is there an alternative to that viewpoint? Could we approach this from a different perspective?
Consequences, implications and analysis	What are the long-term implications of this? However, what if.......happened? How would ......affect ….?
Questioning the question	Why do you think I asked you that question? What was the importance of that question? What would have been a better question?'

STAGE 3 - Grow Wild

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 understand the need for and the process of random sampling.
2. Students have an understanding of how natural systems function within ecological limits and resource constraints.

Learning outcomes

In this very practical science session, we have been inspired by the work of Abrahams and Reiss and their book 'Enhancing learning with effective practical work'. Hence the slightly different style of learning outcomes for this section. By having this very clear link to the learning outcomes and what we want the students to learn, their practical work should be more effective. It is appropriate for this particular learning module where there are many complex variables in this outdoor setting.

Students can:

- Use a key to identify some common plants.
- Use appropriate sampling technique in the survey area.
- Estimate and calculate their population area.

Students can talk about:

- The wide variety of plant species that they find in their school grounds.
- How natural systems work within limits.
- Human activity that exceeds ecological limits or capacity and has negative effects.
- How to take random samples.
- How to calculate an estimate of population size.

Students can later:

- Calculate an estimated population size.
- Use a key to identify different common plant and animal species such as birds, pollinators and trees.
- Use their information to estimate the plant species needed to attract fauna including birds and bees.
- Understand the value of taking random samples.
- Discuss how estimates of population sizes are affected by non-random distribution.
- Understand how natural systems work within limits and use a range of strategies to adapt, optimise and flourish within their school grounds.

Overview of lesson

In this stage students will link their knowledge of biodiversity to their own local situation.

- They will explore their own local 'urban' ecosystem using their GCSE required practical.
- They will use this data to inform their ideas about growing food at school.
- They get the opportunity to be a 'researcher' and then report back to the Eco-Club and the school management team (Stage 4).

Students will carry out a survey of the plants in the school grounds (school field). In this Stage 3 example students will be undertaking a given inquiry based on a required practical activity. Other inquiry examples are given in the teacher's guide for this module

This will be used as the basis for their research on 'growing food in the city'. The data to be used to make a 'recipe' for seed papers for them/their Eco-Club to sow to attract wildlife to pollinate their fruit trees /vegetable patch.

Lesson structure

Introduction

Discuss the links between biodiversity/ pollination and the need for school data. In some schools the students will be the 'researchers' to gain this knowledge for the school Eco Club. After Stage 2, their research questions are likely to be:

- What are the most common plant species we will find in our school grounds?
- What are their different habitats?
- Will these plants grow in these same habitats?
- What are their growing conditions?
- Which parts of the school grounds would be most appropriate for them?
- Which pollinators will we need to attract to create more biodiverse school grounds?

Main: School Grounds Survey

In this practical session the students will be researching their school grounds.

Many organisations have guidance about how to complete a school ground survey. For example, the Field studies Council has superb resources:

https://www.field-studies-council.org/publications/pubs/playing-field-plants-project-guide.aspx

However, for the purposes of this module which is aimed at school science departments we are using the Nuffield 'Practical Biology' site. It describes good mechanisms for sampling techniques with consequent risk assessment and excellent equipment lists for your school technical support service:

http://www.nuffieldfoundation.org/practical-biology/biodiversity-your-backyard

Some schools will also need to take account of their required practical arrangements; for example this is the AQA link P27:

https://filestore.aqa.org.uk/resources/biology/AQA-8461-PRACTICALS-HB.PDF).

The previous Nuffield Foundation site contains enough background detail to successfully complete this. However, we recognise that teachers and indeed some students may want to delve deeper into this subject and using these techniques. For students to answer their questions, they will need to understand how to collect data through sampling. To do this you will need to describe appropriate techniques for students to practice and use in the field.

The Offwell Woodland and Wildlife Trust contains excellent and more detailed descriptions of how, why and when to use these techniques:

http://www.countrysideinfo.co.uk/howto.htm

For example, why do we need to sample:

'If we want to know what kind of plants and animals are in a particular habitat, and how many there are of each species, it is usually impossible to go and count each and every one present. It would be like trying to count different sizes and colours of grains of sand on the beach.'

What is a quadrat? What type should we use? Why do we need to keep the sampling random? How do we record the data? What techniques do we use for analysis?

Continued on page 12...

Lesson structure *(continued)*

... continued from page 11.

Nuffield Practical Biology describes a simple methodology to take the 'human influence' out of the survey…a random number generator (an actual bag of numbers). There are others that use 'computer generated numbers' to help place the quadrats.

With students of this age range, they should be expected to record some typical school ground plants, alongside details of their habitats. It is likely they will be surprised at the number and variety of plants found, particularly in an area they just know as grass. There is also scope for students to develop and investigate hypotheses about the distribution of plants based on observations and measurements of factors such as soil, moisture, light intensity and wind speed. Useful and easy to use identification guides are given in the survey links.

Analysis

Much of the work for this section takes place in Stage 4 of the module when students write the report. However, they will need to know what is expected from them as they carry out their survey.

At this level students should be expected to be able to calculate the estimated population size of a species. For example, the total area sampled multiplied by the number of xx plant counted. Further details to support students are given in the survey link. For the purposes of this learning module this calculation would give an indication of the common species found (or not found), and then in their report they can go onto make recommendations of plant species they can introduce into their school grounds that could improve the school grounds and make it richer and more diverse. In addition, for this module using data from horticultural websites could be useful e.g:

https://www.rhs.org.uk/science/conservation-biodiversity/wildlife/plants-for-pollinators.

Other questions could then include:

- Will pollinators breed in these same habitats?
- What are their breeding conditions?
- Which parts of the school grounds would be most appropriate for them?

There are several methods of quantifying biodiversity apart from comparing a simple list of the number of species identified in each area. One measure is 'species richness'. Others include 'range-size rarity' and 'taxic richness'. Details of suitable web sites are given in the Nuffield Biology survey link.

Plenary

Discussion surrounding the 'deficit' of their school grounds and how to address this. For example, which stakeholders should they involve? How does this link to cities and sustainability? How do we get the plants we need into our school grounds? For example, 'making seed papers':

https://climatekids.nasa.gov/seed-paper/

Homework

Students can complete further research regards cities and biodiversity. For example:

https://www.citylab.com/environment/2015/01/how-singapore-makes-biodiversity-an-important-part-of-urban-life/384799/

The extent of this research will depend on many school factors; more links are given in the teacher's guide.

Common Plants found within School Playing Fields.

Bird's-foot Trefoil - *Lotus corniculatus*

Bulbous Buttercup - *Ranunculus bulbosa*

Cat's-ear - *Hypochaeris radicata*

Common Mouse-ear - *Cerastium fontanum*

Dandelion - *Taraxacum officinale*

Dove's-foot Cranesbill - *Geranium molle*

Common Plants found within School Playing Fields.

Equal-leaved Knotgrass - *Polygonum depressum*

Red Clover - *Trifolium pratense*

Ribwort Plantain - *Plantago lanceolata*

White Clover - *Trifolium repens*

Yarrow - *Achillea millefolium*

Yarrow with flower - *Achillea millefolium*

STAGE 4 - Grow Wild

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

Again as this session is a 'Practical science' session we have used Abrahams and Reiss work (see Stage 3) to guide these and make them more effective.

Students can:

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

Students can talk about:

1. The variety of species on a school field.
2. How natural systems work within limits.
3. Human activity that exceeds ecological limits or capacity and has negative effects.
4. How to take random samples.
5. How to calculate an estimate of population size.

Students can later:

1. Understand the value of taking random samples.
2. Discuss how estimates of population sizes are affected by non-random distribution.
3. Understand how natural systems work within limits and use a range of strategies to adapt, optimise and flourish.

Overview of lesson

In this lesson students think about how to communicate their results from their Required Practical survey to the school Eco Club/STEM Club. 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

Discuss student results from the survey and their recommendations. Focus on the best way of presenting their results to different audiences: school policy makers, students in STEM /Eco Club, Local Authority representatives.

Linking interconnected global issues such as climate change, food supply and biodiversity loss in the context of their local situation is a key objective of this module. For some schools, setting an 'active reading exercise' of these key, sometimes complex, issues can be really useful.

As a pre-homework task for this session you might like to ask students to convert the text from the following articles to:

- Graphics.
- To a mind map.
- To a poem.
- To a song/rap.

You can use the theme of 'Grasping the issues - food, biodiversity and climate change' to frame their work.

The impact of biodiversity loss on food production:

https://www.ft.com/content/ee58eca0-36af-11e9-bb0c-42459962a812 and https://www.theguardian.com/global-development/2019/feb/21/worlds-food-supply-under-severe-threat-from-loss-of-biodiversity.

Furthermore, if as recommended the students have completed the introductory module around climate change issues 'iChange', the following article could be used and will add to their understanding of the interconnectivity of these issues.

Biodiversity loss and climate change:

https://www.theguardian.com/environment/2018/nov/03/stop-biodiversity-loss-or-we-could-face-our-own-extinction-warns-un.

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 growing food at school. These can be added to the 'Messy wall'.
- **Film** - create a 5-minute film communicating to the STEM /Eco Club how you carried out your research and the results.
- **Presentation** - deliver a 5-minute presentation for policy makers including the Senior Leadership Team and/or the Local authority.
- **Report** - write a report laying out your recommendations and evidence for the Eco Club/STEM Club.
- **Other** - Writing and recording a podcast will fit some student's skill set. Particularly if the school wants to create a school radio station.

Plenary

Ask students to share their reviews of each presentation. Groups can review their work and consider ways to improve it in the future (see Student Sheet 2).

Student Sheet 2 - 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.