Making Plants Pop
Weaving local plant knowledge into your teaching

KS3 Science

Emily Fitzherbert and Dr Hattie Roberts

The Lakes School, Windemere

Specialist knowledge for teachers

Around Morecambe Bay and Cumbria, plants hold economic, cultural, historical and environmental significance; from the green pastures of The Lake District supporting local farming economies, to the cultural and historical significance of the red rose of Lancashire. However, the phenomenon of 'plant awareness disparity' is a challenge which impacts the school curriculum across the UK and locally. Formerly known as 'plant blindness', this concept refers to the fact that students frequently fail to appreciate or notice the plants around them, which can lead to naive assumptions that plants are unimportant or have no impact on humans. This disparity hampers young people's local plant knowledge, impeding their appreciation of the societal importance of plants. It also limits education in areas such as botany, ecology and environmental management, which are crucial for inspiring environmental awareness and valuing regional heritage. By bridging the plant awareness gap locally, teachers can empower students by informing them of their local environmental heritage.

We have provided suggestions of where local plant knowledge can be woven into the KS3 curriculum and have provided a more extensive example by designing lesson resources relating to photosynthesis and limiting factors. Whilst principally rooted in the KS3 curriculum, they also provide foundations for links into, the GCSE course content. Specifically, these resources aim to a) inspire students to engage with plants in their immediate vicinity b) enable educators to gain confidence and autonomy when teaching plant-related subjects in a local context.

Simple plant care knowledge and a willingness to approach teaching plant-related content a little differently are the most important skills needed to use these resources. Understanding of environmental datasets and factors affecting the rate of photosynthesis would be useful in using resource 1, while understanding the basic differences between C3 and C4 photosynthesis would be desirable for fully understanding the biological context of the practical activities outlined in resource 2.

Photosynthesis

Light intensity, temperature and carbon dioxide concentrations are largely considered to be the three factors which control the rate of photosynthesis and therefore control plant growth, with the simple thinking being that Photosynthesis is the same in all plants. Students might thus conclude that climate change is good for plants, at least in the north of England. For example, in higher temperatures, more carbon dioxide leads to higher crop growth. Some students might also deduce that rising temperatures might increase cloud cover, reducing light intensity and so counter acting the positive effects of rising CO2 and light levels.

Few students will appreciate that photosynthesis is different in different plants and that sometimes plant cells make a mistake when trying to photosynthesise. Sometimes, an enzyme in chloroplasts called Rubisco captures O2 rather than CO2, meaning that sugars aren't produced. This is called photorespiration and is energetically costly: high photorespiration can reduce crop yield by as much as 39%! The more stressed a plant is, such as when temperatures are high or they don't have enough water, the more likely they are to undergo photorespiration.

Most plants, including important regional crops like wheat, have high rates of photorespiration under those conditions are called C3 plants. However, some plants have evolved ways of reducing losses caused by photorespiration.

These are called C4 plants. Only about 3% of plants are C4 plants, but sugarcane and maize are two important crops that use this photosynthetic pathway. As the climate changes and the global population rises, understanding how C4 crops respond to different environmental conditions, compared with C3 plants, is important for local and global food security.

Resource 2 'Let them grow' provides the opportunity to explore how different plant types respond to different environmental conditions.

Examples in practice

How do **environmental conditions** affect **photosynthesis and plant growth** in The Lake District/Northwest UK?

1. What we know

Photosynthesis is the chemical reaction which captures energy and uses carbon dioxide and water. The products are sugars and oxygen. These sugars are used in plant growth and reproduction.

There are factors that limit photosynthesis, such as light, temperature and water supply.

2. But did you know?

As a renowned National Park full of green spaces and farmland, photosynthesis is the most important chemical reaction in The Lake District and Cumbria. Crop and grass yields are directly affected by photosynthesis. These crops indirectly maintain pasture-fed livestock in the spring and summer. In the winter, livestock are fed on feed meal made from locally produced cereal crops or silage.

3. Important pasture and crop growth stages occur during warm and sunny months

The diagrams show wheat growth over different calendar months. Months marked with a ☀ are the most productive regarding growth and development.

Which months would you expect the most photosynthesis to occur?

Oct	Nov-Jan	Jan-Feb	March ☀	Apr ☀	May ☀	Jun ☀	Jul
Sowing	Root growth, leaf emergence		Stem elongation, flowering		Seed formation	Grain filling	Harvest

4. Why are there only small areas of crop production in Cumbria?

Currently, only 3% of Cumbria is arable land (crop land), while the vast majority is grazing.

This is because there are non-optimal environmental conditions for crop production, such as steep slopes, shallow soil and rocky outcrops.

There are also other factors that limit photosynthesis, such as cloud cover (recorded as sunshine hours per day) and temperature.

5. Comparing wheat and rapeseed production in Northwest and UK over between 2017 and 2018

Table 1 below shows real-world environmental data and wheat and oilseed rape production in the average UK and North West UK in 2018.

1. Are there patterns in environmental conditions which might explain differences in yield between the North West UK and the rest of the UK?
2. Are there differences between environmental data between 2017? Could this account for crop yield?
3. Does OSR (oilseed rape) or wheat seem more limited by environmental factors?

Environmental data

Sunshine	North West	UK Average
2017	3.6hrs	4.1hrs
2018	4.3hrs	4.7hrs

Temperature	North West	UK Average
2017	10.3°C	10.3°C
2018	10.3°C	10.5°C

Rainfall	North West	UK Average
2017	112.1mm	93.2mm
2018	87.5mm	87.8mm

Crop Yield data

OSR yield (t/ha)	North West	UK Average
2017	3.6hrs	4.1hrs
2018	4.3hrs	4.7hrs

Wheat yield (t/ha)	North West	UK Average
2017	10.3°C	10.3°C
2018	10.3°C	10.5°C

6. Can we predict the effects of a changing climate on agricultural productivity?

Check out the **CropNet** demonstrator tool input your area to explore climate projections.

When the grass is green

This resource provides links to local crop and grass productivity, as well as past and future climate projections which allow students to explore the relationship between local environmental conditions, photosynthetic rates, plant productivity and the importance for farming. Extensions to this resource allow students to explore future local climate projections and discuss the future scenarios.

Let them grow

This resource found on the MBC Moodle outlines several experiments that allow students to replicate experiments being conducted at Lancaster University exploring photosynthesis in different type of plants.

Plants everywhere

This resource found on the MBC Moodle is intended to be an online central repository of ideas on other areas of the KS3 National Curriculum where plant-based components can be given a local slant, providing ideas or links to locally focused resources.

Curriculum aims and objectives

The resources we have provided connects to KS3 (year 9) biology lessons.

Head

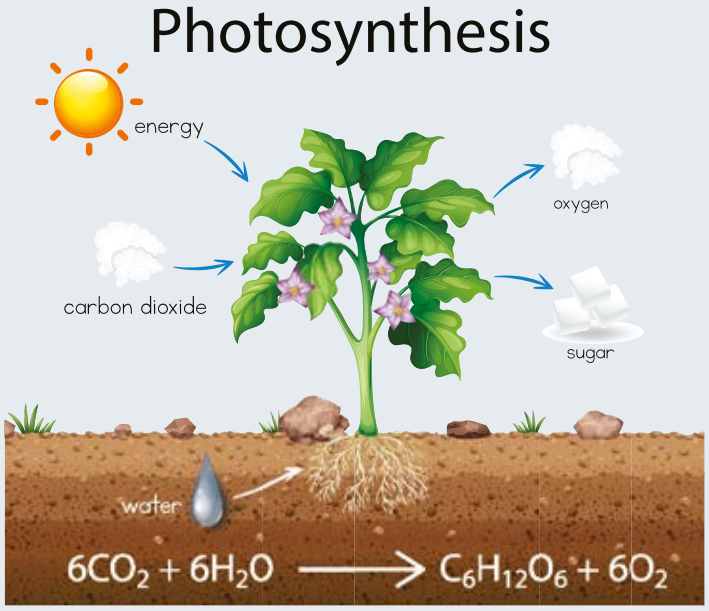
The learning materials aim to engage students intellectually by encouraging critical thinking, curiosity and developing analytical skills, in the context of local photosynthesis. By comparing light levels in Cumbria to the rest of the UK with yield datasets alongside carrying out experiments, students will deepen their understanding of plant biology and how local environmental conditions affect crop productivity and shape the local landscape both past, present and future.

Heart

The provided resources aim to inspire emotional connection to local plants for both students and teachers. The exploration of locally grown plant species and their responses to the immediate environment will allow students to gain and develop a deeper appreciation of our relationships with plants- from local agriculture, to conserving protected species and habitats.

Hands

Students will apply theoretical knowledge to real-world scenarios through a practical experiment. By growing plants under varying light durations, students will gain practical experience in experimental design, data collection and analysis. Similar practical experiments are carried out at Lancaster Environment Centre, again linking this resource to local plant knowledge. This hands-on approach encourages students to actively engage with real-world scientific methods, increasing confidence in their ability to interact with and investigate plants.



Adaptations to extend impact

Bridging the plant awareness gap may be applied through other subjects such as:

History

- Morecambe Bay's tumultuous and troubled links to slavery with importing plants such as cotton, coffee and sugar. These plants shaped Lancastrian and Cumbrian trade and bolstered the local economy, providing heritage goods such as local confections and cotton garments in the eighteenth and nineteenth centuries.

Art and Design

- Plants in local symbols in such as the Lancashire red rose. Using symbols to promote the protection of rare plant species such as the Walney geranium.
- Textures and forms of local plants in different habitats- from coastal plants such as spikey sea holly, to Celtic rainforest plants such as tufted mosses (both habitats are local to Morecambe Bay and Cumbria).

Business

- Much of the local economy is dependent upon the productivity of the land, both from a farming but also tourist perspective. Changes in both plant productivity, plant community composition and wider landscape scale changes have a bearing on future business models of a wide range of industries.