Investigate

Lesson 3
Teacher notes
Measuring carbon captured in trees

Years 9 to 10

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INQuIRY

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Measuring carbon captured in trees

Lesson 3: Teacher notes

This document provides the teacher with the details of the lesson.

At a glance

To provide students with hands-on experiences of carbon biosequestration and geosequestration - carbon capture, transport and storage – as a means of reducing the concentration of atmospheric carbon.

To provide students with an opportunity to explore some of the cutting edge techniques and technologies that have been developed to sequester carbon.

To support students to conduct specific research and investigation in order to answer their own essential question developed during the *Question* phase of the *INQuIRY* process.

Activities:

1. Carbon – capture it, transport it, sequester it

Students:

Investigate ways to capture, transport and store carbon in underground geological locations (geosequestration).

2. Trees are carbon sinks

Students:

Investigate how trees perform as natural living carbon sinks (biosequestration).

3. CCS – the cutting edge of carbon

Students:

Investigate cutting edge carbon capture and storage CCS) techniques and technologies.

Lesson focus

The *Investigate* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records. The *Investigate* phase ensures all students have a shared experience that can be discussed and explained.

In the *Investigate* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships between their observations. Students consider the current views of scientists and deepen their own understanding.

Assessment guide

This assessment guide supports teachers in identifying the types of assessment that are appropriate for this lesson.

Formative assessment is an important aspect of the *Investigate* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. It involves monitoring students' developing understanding of:

> carbon biosequestration and geosequestration - carbon capture, transport and storage – as a means of reducing the concentration of atmospheric carbon

Teachers can also monitor students developing science inquiry skills.

Summative assessment of the science inquiry skills is another important focus of the *Investigate* phase. Rubrics can be used to gauge the level of student achievement on performance tasks.

Key lesson objectives

Science

Students will be able to:

> observe carbon being captured, transported and stored
> measure the amount of carbon capture in a small population of trees
> understand the basis of a small number of cutting edge CCS techniques and technologies.

Literacy

Students will be able to:

> contribute to discussions about sequestration
> record ideas and explanations in words and diagrams in a variety of written modes including experimental report templates.

This lesson also provides opportunities to monitor the development of students' general capabilities.

Teacher background information

Sequestration is the term used for either preventing carbon dioxide produced from various natural and human processes from entering the atmosphere or removing existing carbon dioxide from the atmosphere.

Carbon can be sequestered in two main ways:

Plants can naturally remove carbon dioxide from the air using photosynthesis. This is also known as biosequestration. The process of photosynthesis allows the plant to use the carbon from carbon dioxide as the basis for forming sugars, such as glucose. These sugars support plant growth and development.

Carbon can also be sequestered using a range of human-developed technologies known as carbon capture and storage (CCS) or carbon dioxide sequestration. These technologies are aimed at capturing carbon dioxide emitted from industrial and energy-related sources (such as coal-fired power stations) before it enters the atmosphere, then compressing it, before injecting it deep underground in secure geological formations, and ensuring it remains stored there indefinitely.

All of these processes are also generally known as geosequestration.

By increasing the amount of bio- and geo-sequestration that takes place on the Earth, the amount of carbon dioxide in the atmosphere can, theoretically, be reduced. Hence, these actions have been championed as solutions to climate change by some individuals.

Activity 1: Carbon – capture it, transport it, sequester it

Equipment

For each Student

> Refer to the student worksheets for Experiments 1, 2 & 3 for all equipment.
> Students will each require a copy of each of the student worksheets.

Preparation

> For Experiments 1, 2 and 3:
  – Read through each student worksheet.
  – Familiarise yourself with the safety precautions.
  – Prepare all of the equipment.
  – Conduct a test of each demonstration in advance of the lesson.

Lesson steps

1. Students are to conduct each of the following three experiments in order:
   – Experiment 1: First, capture your carbon
   – Experiment 2: Now, transport your carbon
   – Experiment 3: Finally, sequester your carbon
   The information for each experiment is contained in the relevant student worksheet

Activity 2: Trees are carbon sinks

Equipment

For each Student

> Refer to *Carbon fieldwork - Student worksheet* for all required equipment.

For the Class

> A population of trees of the same species (preferably 20 or more trees; preferably eucalypts) within a small geographical area (preferably no more than 400m2) is required.

Preparation

> *Carbon fieldwork - Student worksheet*:
  – Read through the student worksheet
  – Familiarise yourself with any safety precautions
  – Prepare all of the equipment
  – Check that the carbon calculator website is working.

Lesson steps

1. Take students to planned location.
2. Students to complete all of the tasks outlined in the *Carbon Fieldwork - Student worksheet*.

Activity 3: CCS – the cutting edge of carbon

Equipment

For each student

> CCS – the cutting edge of carbon - Student worksheet

> Access to the article: Marshall 2013, *Small-scale U.S. lab experiment removes CO_2 from atmosphere at relatively low cost*

Preparation

> Read article: Marshall 2013, Small-scale U.S. lab experiment removes CO_2 from atmosphere at relatively low cost

> Check that the following website is accessible: Virgin Earth Challenge www.virginearth.com/

Lesson steps

1. Students to read the article: Marshall 2013, Small-scale U.S. lab experiment removes CO_2 from atmosphere at relatively low cost
2. Facilitate a group discussion of this article using the following suggested question prompts:

> What are the suggested advantages of the method explained in the article compared to other methods?

> What does the article say about the value of this method compared to planting more trees to remove more carbon dioxide from the atmosphere?

> Do you think it would be worthwhile funding further research and development of this new CCS method? Why/why not?

3. Explain to students that most CCS technologies are in their early stages of development, and many ideas are either theoretical only, or have been tested in the lab but have not yet been developed for large-scale industrial use.

   Go to Website: Virgin Earth Challenge www.virginearth.com/ and use 'The Prize' link to explain what the challenge is about, including the prize, the approaches and the rules.

4. Students to choose one of the finalists and use it to complete the *CCS - the cutting edge of carbon - Student worksheet.*
5. Facilitate informal student reports back to the whole group about each of the different finalists. Some possible question prompts include:

> What are the basic ideas behind the CCS technology you researched?

> What are the advantages/disadvantages of this particular CCS technology compared to others?

> Do you think it would be worthwhile funding further research and development of this new CCS method? Why/why not?

Sources:

Marshall, C 2013, *'Small-scale U.S. lab experiment removes CO_2 from atmosphere at relatively low cost',* Climate Wire, viewed 18 December 2013, <http://www.eenews.net/stories/1059981902/print>.

Virgin Earth Challenge 2013, *Virgin Earth Challenge*, viewed 18 December 2013, <http://www.virginearth.com/>.