



Reciprocal reading task: agriculture and ammonia

Education in Chemistry

Sustainability in chemistry 2021

Goal 15: protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss

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Provide context and help build cultural and science capital, while improving learners' reading skills.

Learning objectives

Learners will:

- Work together to decode the text and draw links to their curriculum knowledge.
- Develop skills in oracy and metacognition; improve their ability to read for meaning.

Resources

- Reciprocal reading roles handout: one per group
- 'Agriculture and ammonia' text: one per learner

Instructions

Arrange the learners into groups of four, allocating a role to each learner. The roles are: predict; clarify; summarise; question and build.

Using the reciprocal reading handout, ensure each learner understands all the roles, not just their starting role.

1. The learner with the predict role scans the first paragraph of the text and predicts what they think the text is about and suggests how it links to the topic being studied. They then read the first paragraph to the group.
2. The learner with the summarise role highlights the key ideas up to this point in the reading.
3. The learner with the question and build role asks questions about the paragraph and builds connections to other concepts already learned.
4. The learner with the clarify role addresses confusing parts and attempts to answer the questions posed. They may need to ask other members of the group to help them, use a book/computer or ask the teacher for help.
5. The roles in the group then switch one person to the right, and the next section is read. Learners repeat the process using their new roles.
6. This continues until the entire text is read.

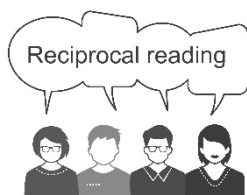
Teaching notes

Arrange the groups and choose one group to help model the process. Explain what the learners must do. Using another piece of text and the model group demonstrate the roles and process. Emphasise that the text and discussion is the activity, they are the creators of the questions and answers.

Throughout the process, the teacher's role is to guide and nurture the learners' ability to use the four strategies successfully within the small group. When observing the learners try to note the level of participation and their strategy competence. These observations form the basis of future planning and teaching.

Once learners become competent in this technique, research suggests the process will be internalised and transferred to their independent reading as a metacognitive strategy. The task provides context and helps build cultural and science capital.

Tip: encourage learners to use note-taking strategies such as selective underlining or sticky notes to help them better prepare for their role in the discussion.



Agriculture and ammonia

Nitrogen is required by all living organisms for the synthesis of proteins, nucleic acids and other organic compounds such as chlorophyll and haemoglobin. Although nitrogen is the most abundant gas in the Earth's atmosphere it cannot enter the food chain. Gaseous nitrogen is converted to soluble ammonia (NH_3), nitrites (NO_2) and nitrates (NO_3) by microorganisms in the soil. The nitrogen-containing molecules are absorbed by plant roots and are used to make organic compounds. These nitrogen-containing compounds are passed to animals when the plants are eaten and pass back into soil when they are excreted as waste or when the organism dies. Microorganisms in the soil break down the dead organisms and waste and cycle the nitrogen back into the atmosphere. Agriculture disrupts this nitrogen cycle by selecting which plants can grow, then crops are harvested and often transported large distances before being eaten, which diminishes the levels of nitrogen compounds in the soil.

Fertiliser is any material of natural or synthetic origin that is applied to soil or to plant tissues to supply plant nutrients. For thousands of years, humans have been using natural fertilisers such as manure, bones and ash to supplement the soil. Guano is a natural mineral deposit formed in arid climates from accumulated desiccated seabird excrement. The guano mined from islands off the coast of Peru has a very high nitrogen, phosphate and potassium content making it a very effective fertiliser. By the mid-19th century, guano fertiliser from Peru was being applied in Europe, crop yields shot up and so did the demand for fertiliser. Meeting the demand for guano resulted in ecological degradation because the mining continued throughout the birds' breeding season destroying millions of seabirds, their eggs and their roosts. The rate of removal far exceeded that of replenishment and soon, the guano mines were exhausted. Without the high-quality fertiliser, the industrialised nations struggled to feed their growing populations: Great Britain for example was forced to import most of its wheat. Chemistry researchers were tasked with trying to develop and manufacture synthetic fertilisers to help solve the coming food crisis.

In 1909, German scientist Fritz Haber provided a solution when he devised a way to transform nitrogen in the air into fertiliser by producing ammonia. Commercial scale production of ammonia was developed by Carl Bosch, a German chemist and engineer. The Haber-Bosch ammonia production process is called one of the greatest inventions of the 20th century; without it almost half the world's population would not be alive today. However, ammonia manufacture is energy intensive, requiring very high pressure (200 atmospheres) and temperature (450°C) and then cooling conditions to liquefy the ammonia. After sulfuric acid, ammonia is the most produced chemical in the world, its production accounts for approximately 2% of worldwide fossil fuel energy use and generates approximately 420 million tonnes of CO_2 annually. In effect, fossil fuel energy is pumped into our food supply and due to population increase the demand for fertiliser is projected to double in the coming century.

Human alteration of the global nitrogen cycle, mainly through the application of ammonia-based fertilisers, is a contributor to global declines in biodiversity, widespread air quality problems and greenhouse gas emissions across the world. Soil provides 98.8% of human food but is also important for carbon storage, greenhouse gas regulation and flood mitigation. We are essentially destroying the functionality of soil, so more and more synthetic fertilisers must be applied to maintain crop yields. Adding high levels of nitrogen compounds to soil stimulates microbial growth which removes the carbon in the soil. The carbon is released into the atmosphere as the greenhouse gas, carbon dioxide. Ammonia-based fertilisers are highly soluble and run off into rivers causing eutrophication. The results of which include ocean 'dead zones', where blooms of algae near the surface block out sunlight and kill the fish below.

Sustainable development is defined as meeting the needs of current generations without compromising the ability of future generations to meet their own needs. The current production and use of synthetic fertilisers are not sustainable. Soil is a finite resource and it is being degraded by intensive agricultural production. Everyone has a role to play in the careful management of our resources by reducing the amount of waste created, reusing and recycling natural resources. Meanwhile, the demand for a green ammonia, made by 100% renewable and carbon-free production, is greater than ever. Ammonia also has the potential to be used as energy storage, a zero-carbon fuel and as a hydrogen carrier.

Reciprocal reading roles

Reciprocal reading



Predict

What is the text about?

How does that link with the topic you've been studying?

What new information will this text provide?

What clues have you used?

Is your prediction logical?

Reciprocal reading



Clarify

Identify tricky words, phrases or ideas as you read:

'What does this word mean?'

'How is this word pronounced?'

Were there any ideas that you don't understand?

What strategies can we use to figure this out?

Reciprocal reading



Question and build

Ask questions about the passage.

Is there anything that you did not understand or that did not make sense?

Ask for this to be clarified, do you understand the answer?

Ask if everyone agrees with the answer, if not, what additional information is needed?

How does this paragraph connect to or develop earlier information?

Reciprocal reading



Summarise

What are the most important ideas?

What does the author want you to learn from this?

In your own words, explain what this passage is about.

Ask if anyone thinks you've missed something out.

Ask if everyone agrees with the summary.