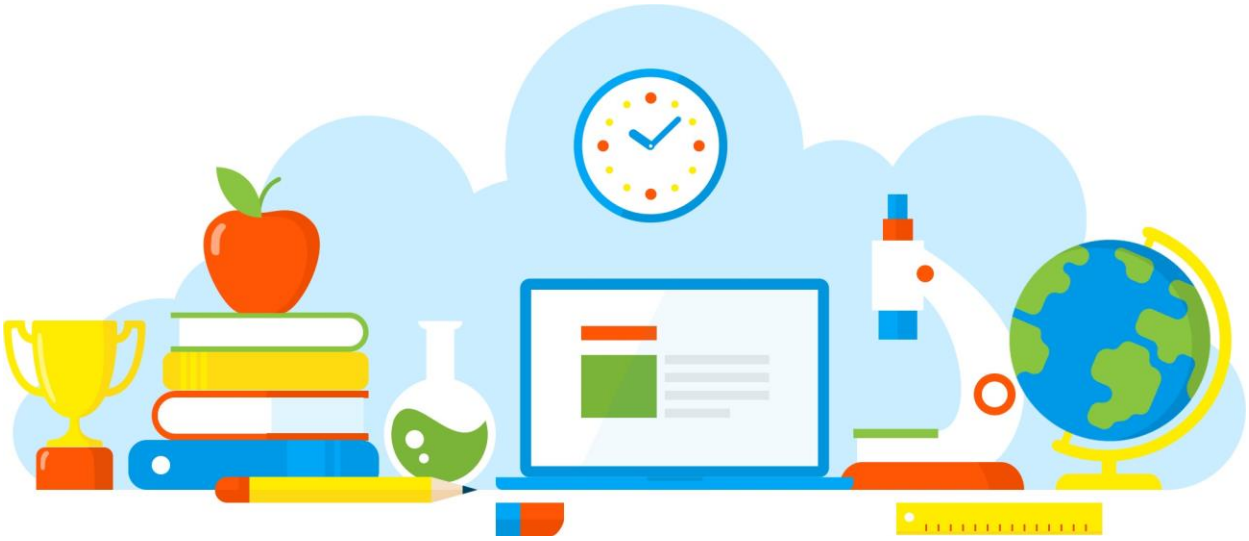

Water Quality

Year 5

ETP5007 Science in Primary Education
May 19, 2019
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VICTORIA UNIVERSITY

WATERWATCH Victoria

river DETECTIVES

Melbourne Water

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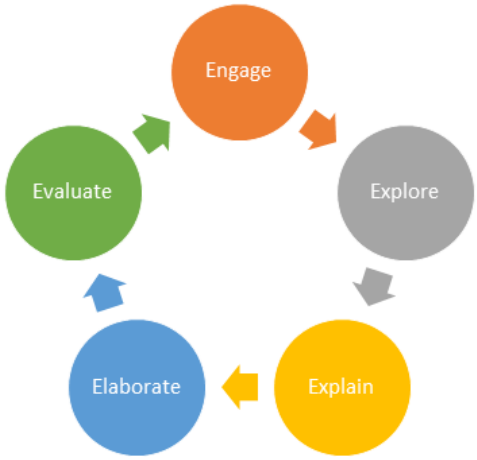
Executive Summary

Overview of the Unit of Work

The 5E Instructional Approach is a constructivist approach to learning, where students build new ideas and knowledge based on their prior understanding of a topic. According to Bybee (1997) 'students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment' when using this approach. When applied to Year 5 Science, this model allows students to redefine their original preconceptions and elaborate on their learning through collaboration and self-reflection. Students are encouraged to learn through hands-on experiences and develop skills to help them question and understand the world they live in. The approach includes five key stages including *Engage, Explore, Explain, Elaborate and Evaluate:*



The 5E Instructional Model

The *Engage* stage aims to ignite the students' interest and curiosity about the topic. During this stage, students ask questions and think deeply about the topic; this will help teachers to identify students' prior knowledge and understanding, which will enable a better learning outcome and contribute to student learning.

The focus of the *Explore* phase is to allow students to inquire and investigate their ideas, discuss their observations and continue to develop their documentation skills.

In the *Explain* phase, students are tasked to show their developing understanding of the topic. Students may discuss their observations and seek to discover patterns or relationships within their findings in order to deepen their understanding.

The *Elaborate* phase gives students the opportunity to practice their planning and investigation skills. Students will further investigate their findings and deepen their understanding of science

and inquiry.

The *Evaluate* phase allows students to reflect on their learning and summarise their understanding.

This unit of work addresses the Science Victorian Curriculum (2019) across a 6-lesson plan structure. The lesson sequence will be broken down as follows:

1. Wondering about Water
2. Planning and Preparation
3. Pond Excursion
4. Water Quality Detectives
5. Water Quality Researchers
6. Community Water Use

Links to Victorian Curriculum

The Victorian Science Curriculum has two interrelated strands: Science understanding and Science Inquiry Skills — that together 'provide students with understanding, knowledge and skills through which they can develop a scientific view of the world' (Victorian Curriculum 2019).

This unit of work integrates both strands of the Victorian Science curriculum. The table lists sub-strands and content descriptions for Year 5.

Science Understanding	
Science as a Human Endeavour	Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people's lives (VCSSU073)
Biological Sciences	The growth and survival of living things are affected by the physical conditions of their environment (VCSSU075)
Science Inquiry Skills	
Questioning and Predicting	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules (VCSIS082)
Planning and Conducting	With guidance, plan appropriate investigation types to answer questions or solve problems and use equipment, technologies and materials safely, identifying potential risks (VCSIS083) Decide which variables should be changed, measured and controlled in fair tests and accurately observe, measure and record data (VCSIS084)

Recording and Processing	Construct and use a range of representations, including tables and graphs, to record, represent and describe observations, patterns or relationships in data (VCSIS085)
Analysing and Evaluating	Compare data with predictions and use as evidence in developing explanations (VCSIS086) Suggest improvements to the methods used to investigate a question or solve a problem (VCSIS087)
Communicating	Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships (VCSIS088)

Source: Victorian Curriculum 2019

Unit at a Glance

Phase	Lesson	At a Glance
ENGAGE	**Lesson 1** Wondering about water	To capture students' interest and enquire about their prior knowledge about the quality of water (one of Earth's resources) and how they think they can measure it. To enable students to describe the difference between drinkable and undrinkable water. And, to elicit students' questions about water then, share their ideas by creating a 'Wondering about water' wall.
EXPLORE	**Lesson 2** Planning and preparation	To provide students with information about how to measure the quality of pond water beyond the surface of assumptions and 'what it looks like' by creating an understanding of some basic abiotic factors affecting water.
	Lesson 3 Pond excursion	To provide students with hands-on, shared experiences of pond water and the opportunity to collect pond water samples for lab testing purposes. To elicit questions about the difference in conditions for animals and humans to drink pond water.
	Lesson 4 Investigating water quality ***Session 1*** *Water detectives*	To provide instructions and support students to conduct four investigations of the collected pond water samples, at the lab.

	Session 2 *Water detectives*	To familiarise students with the measuring kit and the basic principles of some of the common compounds found when measuring the quality of water.
EXPLAIN	**Lesson 5** Analysing water quality results - Graph It!	To enable students to make comparisons of their results from the pond water lab testing against the benchmarks of drinkable water quality. To encourage students to graph their results and discuss their explanations to answer the 'what, why and how' in measuring the quality of water.
ELABORATE **EVALUATE**	**Lesson 6** Community water use & ethics	To enable students to understand some ethical implications that affect the quality of water and what the consequences are of that to the wider community and to our Earth. To provide opportunities for students to represent what they know about water quality and how it is measured, how they can contribute to reduce adverse effects of ethical implications and to reflect on their overall learning during the unit.

Lesson 1: Wondering about Water

Aims of the stage

In this stage students will engage with new material and information about water. Students will share their prior knowledge about water and discuss and identify questions they have about water quality.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- describe and compare water
- record and share ideas about water
- discuss ideas and questions about water quality for the class 'Wondering about Water' wall.

Assessment Focus

Diagnostic Assessment

In this lesson, students' prior understanding and knowledge about water quality (one of Earth's resources) will to help students to answer their questions on the quality of water and how it will be monitored. The students' science inquiry skills will also be pre-assessed.

Teacher Background Information

As water is the most basic element needed for life to exist, it is an essential element for many living and nonliving organisms. The quality of water has a large impact on the environment we live in and influences the way in which communities use water for recreation activities and drinking. Water quality is also a representation of a healthy environment which supports a rich and varied community of organisms (Boyd 2015). As water is collected through various streams such as bays, oceans and rivers, the quality of the water is impacted by humans on a daily basis which can ultimately affect ecosystems.

The quality of water is determined by multiple factors that are regularly tested in order to meet certain requirements put forward by the government. According to Melbourne Water Corporation (2017), Melbourne has some of the world's best drinking water based on clarity (turbidity), minerals, colour, pH, bacteria, chlorine and contaminants. The results of these factors are influenced by physical, chemical and biological characteristics, which is important for teachers to have an understanding of in order to construct and conduct effective lessons for their students.

Water quality can also be assessed by the amount of living organisms (biota) found in the stream, which are also affected by physical, chemical and biological factors (Khatri & Tyagi 2014).

Initially, students will be asked to determine what constitutes good water quality. This will involve observation of how certain contaminants - food colouring, mud and detergent - interact with water and affect its quality. Students will need to think about what the contaminants are made of, why they make the water undrinkable and the negative effects that they may have on water quality. This will happen before the exploration stage where they will partake in experiments to establish the difference in the quality of water obtained from different streams.

Equipment

For the class	For each student
● Four different water-filled containers (tap water, water with detergent, water with mud, water with food colouring) ● Small containers ● 'Wondering about Water' Wall ● Sticky notes	● Science journal

Lesson Steps

1. Introduce four different water-filled containers to the class.
    a. Tap water
    b. Tap water with detergent
    c. Tap water with mud
    d. Tap water with food colouring
2. Explain that students will observe, describe, and compare the quality of the different kinds of water presented.
3. Distribute small containers and allocate water to students.
4. Ask the students to observe and record their ideas on their science journal.
    ❖ Guide questions:
    ● Using your senses, how can you describe the different kinds of water?
    ● Which is safe to drink? Why? What made you think so?
    ● What is good quality water? What makes it good?
    ● What is bad quality water? What makes it bad?
5. Students share their observations and ideas to the class.

6. Ask the students to write down questions they have about water quality and post it on the class ‘Wondering about Water’ wall (Appendix A).
7. Students add cut out photos and information, such as brochures, newspaper clippings, to the ‘Wondering about Water’ wall throughout the unit.
8. Excursion forms for Water Collection Excursion are handed out - ensure students are aware if permission is not received by the due date, they will not be able to participate in the excursion.

Alignment with Victorian Curriculum

Science

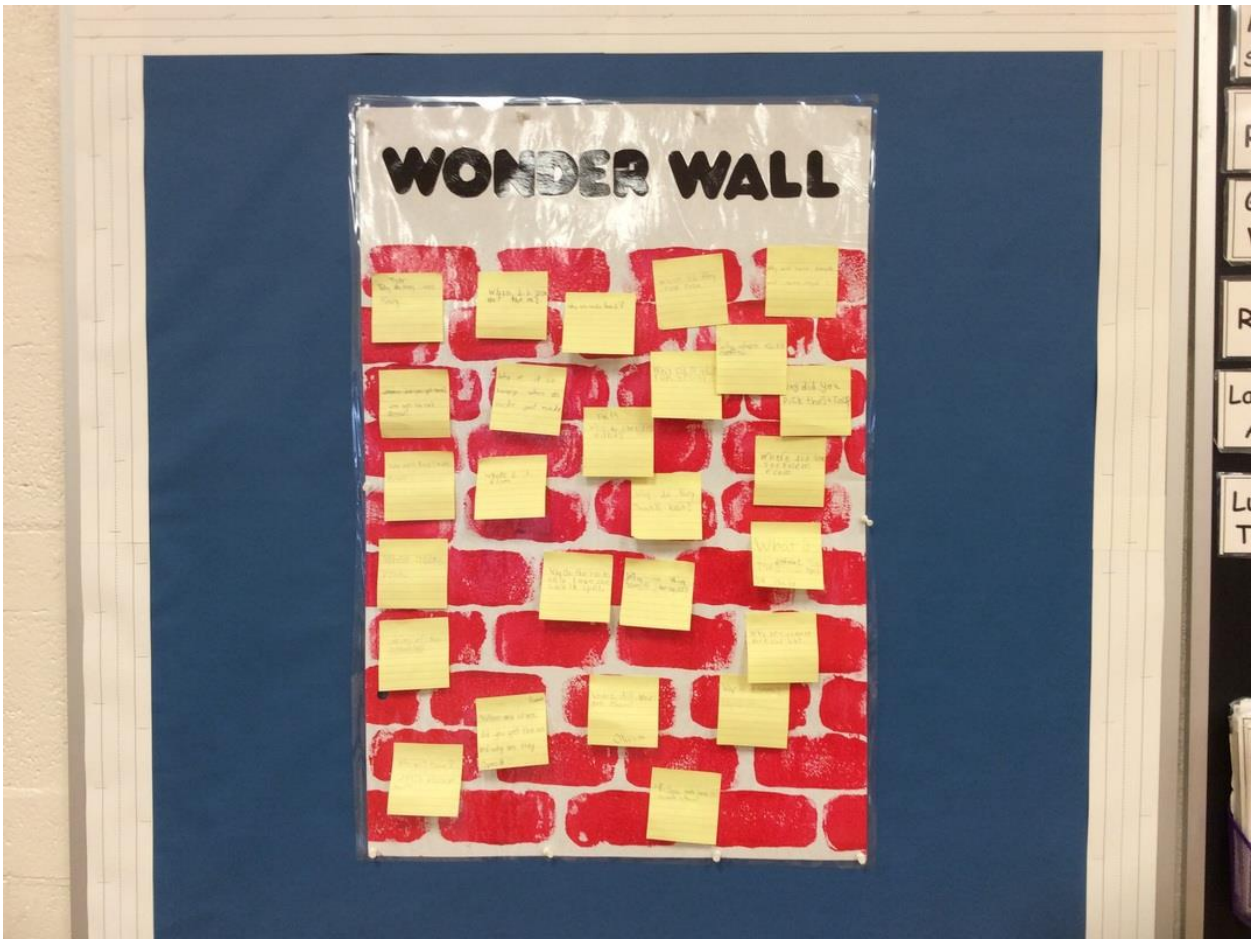
- With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be based on previous experiences or general rules (VCSIS082).
- Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people’s lives (VCSSU073).

Visual Arts

- Create and display artwork considering how ideas can be expressed to an audience (VCAVAP031**).**

Appendices

Appendix A - ‘Wondering about Water Wonderwall’ (Example)



Wonder Wall (Inspiring Inquiry 2015)

Lesson 2: Planning and Preparation

Aims of the stage

Students will explore and discuss factors of water quality in preparation for the pond excursion. Students will plan for the excursion while considering safety concerns and the objective of the trip.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- actively participate in an informative discussion about planned pond excursion
- identify and classify abiotic and biotic factors that affect water quality

Assessment Focus

Formative Assessment

In this lesson, students' developing understanding of basic chemicals found in water will be monitored. They will be given recursive feedback that aims to extend their learning.

Teacher Background Information

Water Collection Excursion Preparation

1. Permission forms for Water Collection Excursion need to be created and distributed with a due date specifically indicated.
    a. It is important to know the school's policy on safety for excursions.
    b. List of health records for allergies or other health issues is easily accessible.
    c. First aid kits are stocked
    d. Emergency contact numbers are documented
    e. Organisation for transport or 'walking school bus'
    f. Request assistance from parents or other teachers to attend and help with the formalities of the excursion.
    g. Request a change of clothes as students may become wet whilst collecting, students will need to wear water-protective footwear such as gumboots.
2. Organisation of protective gear - plastic gloves, shoe protection for students that do not have the correct shoes on the day
3. Water collection bottles/jars are sterilised, with group names clearly labelled on each

Abiotic and Biotic Factors

There are many factors that influence every part of the environment, which can be categorised in both abiotic and biotic factors. Abiotic factors are the non-living parts of the environment that have a major impact on ecosystems. These factors include:

- Water
- Sunlight
- Oxygen
- Soil
- Temperature

Biotic factors include all the living organisms in the ecosystem. Biotic factors interact with each other in the ecosystem in many ways, which is broken down into three categories:

- Producers - Plants and algae that absorb the energy from sunlight to produce food and energy to grow
- Consumers - Organisms that eat producers
- Decomposers - Organisms that break down dead material

Phosphate

Phosphate is a key element that is a necessity for the growth of both plants and animals, and exists in three forms:

- Orthophosphate – Produced by natural processes and found in sewage
- Metaphosphate – Found in detergents
- Organically bound phosphate – Occur from the breakdown of organic pesticides

If high levels of phosphate are found in pond water it will have a negative effect on the algae, resulting in rapid growth and using up large amounts of oxygen. Excessive phosphate leads to the death of algae and plants, which is then consumed by aerobic bacteria and ultimately leading to the death of many living organisms found in the water (Paul 2011).

Extreme amounts of reactive phosphorus can cause algal blooms, making it unsuitable for human or animal use. For humans, phosphate is essential for bone development and energy metabolism, however high levels of phosphate found in drinking water is undesirable as it may lead to digestive disorder. By testing the level of phosphate found in the pond water sample collected, students will be able to determine the quality of the water using the following guidelines:

Water Quality	Excellent	Good	OK	Poor
mgP/L	<0.01	0.011 – 0.025	0.026 – 0.1	>0.1

Nitrate

Nitrate (NO_3) is a compound that is formed when both nitrogen and oxygen combine together. Nitrates are an important source of nitrogen which is essential for plants and animals to synthesize amino acids and proteins. However, high levels of nitrate in lakes and ponds contribute to a condition called eutrophication, which refers to the excessive growth of plants and algae, leading to a reduction of water quality that is harmful for both animals and humans. Sources of nitrate ions include:

- Agriculture runoff
- Urban runoff
- Animal feedlots and barnyards
- Municipal and industrial wastewater
- Automotive and industrial emissions
- Decomposition of plants and animals

Through the use of the test kit, students will be able to find out the total amount of nitrate in the water. Students will then determine the quality of the water using the following guidelines.

Water Quality	Excellent	Good	OK	Poor
mg/L	0	10-25	50-250	500

pH

pH is a measure of the acidity or alkalinity found in the water. It is important to maintain neutral concentrations of pH as animals and plants are very sensitive to changes in concentration levels. A large increase or decrease of pH concentration in the water will have a negative impact on the number and diversity found within the water.

There are many factors that affect the concentration levels of pH in the water, from both natural and unnatural influences such as:

- Geology and soil type
- Water runoff
- Biological activity
- Number of algae and plant growth
- Rainfall
- Salinity
- Burning fossil fuels
- Agriculture and urban development

Students will be able to determine the quality of the water sample in regard to the pH concentrations by following the guidelines as listed:

Note: The results can vary depending on which part of the catchment the water sample is collected. The pH scale is from 0-14, with 0 being most acidic, 7 is neutral, and 14 is most alkaline.

Water Quality	Excellent	Good	OK	Poor
pH	6.5-7.5	6.0-6.4 7.6-8.0	5.0-5.9 or 8.1-9.0	<5 or >9

Ammonia

Ammonia is a natural product of decay from organic nitrogen compounds, however if found in water with abnormal concentrations it can negatively impact the quality of water and be hazardous to the aquatic ecosystem. Ammonia usually enters the water streams from agricultural runoff or runoff in urbanised areas. Concentrations of ammonia below 0.03 ml/L is considered low and will limit plant and algae populations. Ammonia can be toxic to fish and other animals, which also depends on the concentration of other influences such as pH and temperature.

Water Quality	Excellent	Good	OK	Poor
Ammonia ml/L	0-0.01	0.01-0.02	0.03	>0.03

Oxygen

Oxygen is a necessity for all organisms with aerobic respiration (breathing), which comprises many freshwater species (Bronmark 2005). Through the photosynthesis phase of plants, carbon dioxide and sunlight are taken in while releasing oxygen. One of the major inputs of oxygen into ponds and lakes is through the photosynthesis process of plants, which also includes the plants that are under water, such as algae, releasing oxygen directly into the water.

The level of oxygen that may be available in streams of water is influenced by abiotic and biotic factors, such as:

- Temperature of the water
- Photosynthesis activity from brighter light
- Decomposition activity of organisms
- Mixing and turbulence
- Salinity

The amount of oxygen found in water is an important indication of the quality of water due to the influence it has on living organisms (Fondriest Environmental 2019). Note that this abiotic factor

will not be tested in this lesson sequence, however this content knowledge is for teacher background information only.

Equipment

For the class	For each student
● 'Wondering about Water' Wall ● T-chart Abiotic vs. Biotic factors	● Abiotic fact sheets - pH, Phosphorus, Nitrate and Ammonia ● Science Journals ● Padlets to clarify words

Lesson Steps

1. Indicate to students that the purpose of the lesson is to plan and prepare for the pond excursion in the next lesson; to do so they require to have knowledge about pond water quality and that it is different to how we define drinking water quality.
2. Students think-pair-share what they believe makes pond water either good quality or bad quality.
3. Students share their ideas with the class and wonderings are added to the wonder wall.
4. Explain the difference between abiotic and biotic factors.
5. Draw a T-chart on the board and make a list of abiotic and biotic factors that affect water quality with the students using:
    - ❖ Guided questions:
    - What non-living things can affect water quality?
    - What living things can affect water quality?
    - What do you know about water that humans do to make it bad quality?
4. Outline the 4 key abiotic factors that will be investigated once pond water excursion is completed (pH, Phosphate, Nitrate and Ammonium)
5. Provide students with an abiotic factor sheet (pH, Nitrate, Phosphate and Ammonium) (Appendix B) and ask students to skim, scan and highlight words that need clarification the main points and key ideas of the non-fiction articles (Appendix A).
6. Ask students to create their own summary of the abiotic factors that will be investigated.
7. Make a list of safety rules for the pond excursion including protective gear items, ethical issues such as ensuring ecosystems are not harmed and habitats are not affected in anyway whilst on excursion.
8. Students are to be organised into four groups: Red, Blue, Green and Yellow

Alignment with Victorian Curriculum

Science

- With guidance, plan appropriate investigation types to answer questions or solve problems and use equipment, technologies and materials safely, identifying potential risks (VCSIS083)

English

- Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences, and present and justify a point of view or recount an experience using interaction skills (VCELY337)

Appendices

Appendix A: Summary Table

Name:
Text:

Words for Clarification	Main Idea
Skim, Scan Facts and Ideas	**Summary**

Ammonium and Nitrate - Nitrogen Cycle

Ecosystem
The Nitrogen Cycle

The nitrogen cycle describes how nitrogen moves between plants, animals, bacteria, the atmosphere (the air), and soil in the ground. Nitrogen is an important element to all life on Earth.

Different Nitrogen States

For Nitrogen to be used by different life forms on Earth, it must change into different states. Nitrogen in the atmosphere, or air, is N_2. Other important states of nitrogen include Nitrates ($N0_3$), Nitrites (NO_2), and Ammonium (NH_4).

Nitrogen Cycle

This picture shows the flow of the nitrogen cycle. The most important part of the cycle is bacteria. Bacteria help the nitrogen change between states so it can be used. When nitrogen is absorbed by the soil, different bacteria help it to change states so it can be absorbed by plants. Animals then get their nitrogen from the plants.

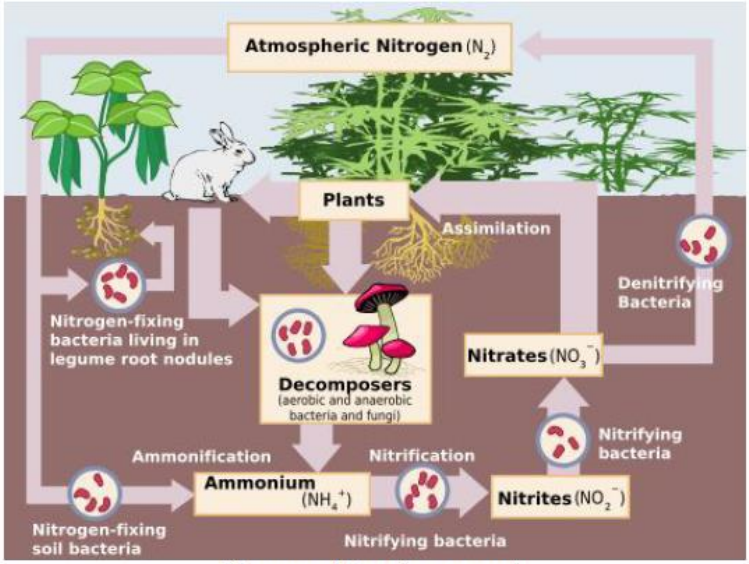


Diagram of the nitrogen cycle

Processes in the Nitrogen Cycle

- Fixation - Fixation is the first step in the process of making nitrogen usable by plants. Here bacteria change nitrogen into ammonium.
- Nitrification - This is the process by which ammonium gets changed into nitrates by bacteria. Nitrates are what the plants can then absorb.
- Assimilation - This is how plants get nitrogen. They absorb nitrates from the soil into their roots. Then the nitrogen gets used in amino acids, nucleic acids, and chlorophyll.
- Ammonification - This is part of the decaying process. When a plant or animal dies, decomposers like fungi and bacteria turn the nitrogen back into ammonium so it can re-enter the nitrogen cycle.
- Denitrification - Extra nitrogen in the soil gets put back out into the air. There are special bacteria that perform this task as well.

Why is nitrogen important to life?

Plants and animals could not live without nitrogen. It is an important part of many cells and processes such as amino acids, proteins, and even our DNA. It is also needed to make chlorophyll in plants, which plants use in photosynthesis to make their food and energy.

How have humans altered the nitrogen cycle?

Unfortunately, human activity has altered the cycle. We do this by adding nitrogen into the soil with fertilizer as well as other activities that put more nitrous oxide gas into the atmosphere. This adds in more nitrogen than is needed by normal cycle and upsets the cycle's balance.

Fun Facts

- Around 78% of the atmosphere is nitrogen. However, this is mostly not usable by animals and plants.
- Nitrogen is used in fertilizer to help plants grow faster.
- Nitrous oxide is a greenhouse gas. Too much of it can also cause acid rain.
- Nitrogen has no color, odor, or taste.
- It is used in many explosives.
- About 3% of your body weight is nitrogen.

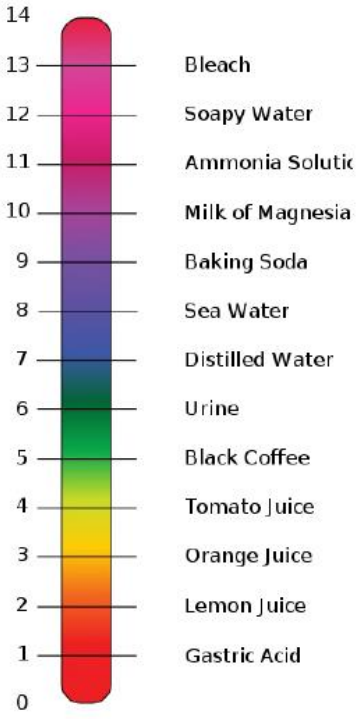
Source: Ducksters.com

Acids and Bases

Acids and bases are two special kinds of chemicals. Almost all liquids are either acids or bases to some degree. Whether a liquid is an acid or base depends on the type of ions in it. If it has a lot of hydrogen ions, then it is an acid. If it has a lot of hydroxide ions, then it is a base.

pH Scale

Scientists use something called a pH scale to measure how acidic or basic a liquid is. pH is a number from 0 to 14. From 0 to 7 are acids, with 0 being the strongest. From 7 to 14 are bases with 14 being the strongest base. If a liquid has a pH of 7, it's neutral. This would be something like distilled water.



Strong Acids and Bases

Acids with a low pH of around 1 are very reactive and can be dangerous. The same is true for bases of a pH near 13. Chemists use strong acids and bases to get chemical reactions in the lab. Although they can be dangerous, these strong chemicals can also be helpful to us.

*** Never handle acids or bases in a chemistry lab unless supervised by your teacher. They can be very dangerous and can burn your skin.

Acids and Bases in Nature

There are many strong acids and bases in nature. Some of them are dangerous and used as poisons by insects and animals. Some are helpful. Many plants have acids and bases in their leaves, seeds, or even their sap. Citrus fruits like lemons and oranges have citric acid in their juice. This is what makes lemons taste so sour.

Acids and Bases in our Bodies

Our bodies use acids and bases too. Our stomachs use hydrochloric acid to help digest foods. This strong acid also kills bacteria and helps to keep us from getting sick.
Our muscles produce lactic acid when we exercise. Also, our pancreas uses a base called an alkali to help with digestion. These are just a few examples of how the chemistry of bases and acids help our bodies function.

Other Uses

Science and technology makes good use of acids and bases. Car batteries use a strong acid called sulphuric acid. Chemical reactions between the acid and lead plates in the battery help make electricity to start the car. They are also used in many household cleaning products, baking soda, and to make fertilizer for crops.

Source: Ducksters.com

Phosphorus

Phosphorus is a chemical element that glows in the dark and in moist air. Its name comes from the Greek word *phosphoros* which means “light bearing”.

Characteristics and properties

Pure phosphorus exists in three forms. The most common forms of phosphorus are white and red phosphorus. A less common form is black phosphorus.

White phosphorus is a colourless, soft, waxy solid. If it is exposed to air it can burst into flame emitting thick, strong-smelling smoke. It is very poisonous.

If it is exposed to sunlight or heat, white phosphorus turns into red phosphorus.

If it is exposed to high pressure, white phosphorus turns into black phosphorus.

Where is phosphorus found?

Phosphorus is not found freely in nature on Earth. Instead, it is found in most rocks, plants, minerals and animals as part of other compounds. Compounds are a combination of elements. Scientists have researched and found ways to separate phosphorous from these compounds in order to use it.

How is phosphorus used?

The main use of phosphorus in industry is to manufacture fertilisers because it is an important element for plants and animals.

Red phosphorus is used to make pesticides and safety matches.

White phosphorus is used to make chemicals that are found in detergents, fertilisers and toothpaste.

Black phosphorus has no important commercial uses.

Lesson 3: Pond Excursion

Aims of the stage

In this stage, students will be given the chance to explore and experience new learning in a hands-on excursion to the pond. Students will collect water samples and demonstrate safe use of scientific equipment. This stage will form the basis of discussion and reflection in the explain stage.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- raise questions for inquiry and elicit their existing beliefs
- collect pond water
- use oral, written, and visual language to record and report observations of pond water.
- discuss ideas and questions about water quality and its impact on living things for the class 'Wondering about Water' wall.

Assessment Focus

Formative Assessment
In this lesson, students' developing understanding of basic chemicals found in water will be monitored. They will be given recursive feedback that aims to extend their learning. The students' science inquiry skills will also be assessed.

Teacher Background Information

There are many organisms that live in pond water that depend on good quality water in which they can grow and reproduce. As there are many factors that contribute to the quality of water such as physical, biological and chemical characteristics, a growing environmental concern is the impact humans play on water quality levels and how it can be managed in order for organisms to be able to live, grow and reproduce.

By experimenting on the levels of ammonium, pH, phosphate and nitrate that are found in pond water, students will be able to recognise the quality of the water and determine whether it is in excellent, good, average or poor condition. By following the guidelines on what constitutes good quality water, students will be able to engage in discussion of what it means to have good quality pond water and how it affects organisms found within. The higher the level of nitrate and phosphorus found in the water, the lower the quality of the water and more detrimental effects it has on the living organisms.

Furthermore, good quality pond water can be characterised by sufficient oxygen levels, appropriate temperature, transparency, limited levels of metabolites and other environmental factors affecting living organisms (Bhatnagar & Devi 2013).

Equipment

For the class	For each student
• Water Collection Containers labelled in colour groups • Collection box for easy transportation (plastic container)	• Excursion permission forms and emergency contact details • Science journals

Lesson Steps

1. Once students are at the excursion revisit the excursion rules that were put together as a class.
2. Explain to students the importance of not harming any habitats throughout the excursion; ask guiding questions:
    a. Why is it important that we do not harm or affect any habitats?
    b. What could happen if we took animals from their habitat
    c. How can we ensure we are not affecting their habitats in any way?
3. Organise students into their groups - red, blue, yellow and green and distribute water collection cups to each group
4. Model how to collect water from the pond/lake safely.
5. Students head out to different areas of the pond bank and collect their water samples
6. Students place collections into the classroom collection box
7. Gather students together and identify as a class any biotic factors that may be harming the pond at the moment
8. Students work in pairs and identify any items that may be affecting the pond and record these in their science journal
9. End of excursion - students head back to school.

Alignment with Victorian Curriculum

Science

- With guidance, plan appropriate investigation types to answer questions or solve problems and use equipment, technologies and materials safely, identifying potential risks (VCSIS083)

Appendices

Padlet link: https://padlet.com/airom_camua/fkgbyutirutu

Padlet QR Code:

Pond Excursion – Wondering about Pond Water Quality

Lesson 4: Investigating Water Quality

Aims of the stage

In this stage students will practice their measurement and interpretation skills. Students will further explore and interpret their findings from the pond excursion.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- measure ammonium, pH, phosphate and nitrate in water
- carefully read follow instructions for measuring
- graph findings on the classroom Water Quality charts

Assessment Focus

Formative Assessment
In this lesson, students' developing understanding of basic chemicals found in water will be monitored. They will be given recursive feedback that aims to extend their learning. The students' science inquiry skills will also be assessed.

Teacher Background Information

In this lesson students will be experimenting the water quality of their samples using the test kits. A VISOCOLOR test kit is used to test various compounds found in the water and by following the guidelines of what makes water quality excellent, good, average or poor, students will be able to determine the quality of the water.

Students will use the test kit to run tests on the sample of water they have obtained from the pond, and measure the level of PH, ammonium, phosphate and nitrate. It is important that students follow the instructions of the test kit and how to measure each compound, as results may vary and affect the accuracy of the test.

Results can be read directly in mg/L or ppm (parts per million).

Results for ammonium, nitrate, pH and phosphate can be read using the colorimetric method which is explained in more detailed in the instruction manual inside the test kit. Colorimetric VISOCOLOR SCHOOL test kits use two test tubes which are both used for the experiments. Reagents are only added to one of the test tubes (generally tube B). After waiting long enough for the reaction to occur, as instructed in the manual, the comparator is to be moved along the colour chart available in the test kit until the colours of tube A and B match as closely as possible. The results can be read on the upper side of the comparator.

The pH test is used to find out how acidic the water sample is. The scale runs from 0-14, with 0

being most acidic, 7 is neutral and 14 being most alkaline. As animals and plants are very sensitive to changes in pH, the water is considered excellent when kept within natural range of pH units between 6.5 and 7.5.

The test kit is used to measure the concentration of nitrate to find out about the total amount of inorganic nitrogen found within the water. Nitrate is measured in milligrams per litre (mg/L) and the quality water is considered excellent when there is no concentration of nitrate found in the sample.

Phosphorus is a nutrient that is essential for life within the aquatic ecosystem. Excessive amounts of reactive phosphorus can cause algal blooms, making it unsuitable for animal or human use. Through the use of the test kit, the reactive phosphorus is measured in milligrams per litre (mg P/L), where less than 0.01 mg P/L found in the water is considered to be excellent.

Ammonia is one of the forms of nitrogen that exists in aquatic environments such as ponds. However, elevated concentrations of ammonia found in the water is detrimental to aquatic life, causing direct toxic effects. Using the test kits, students will measure the concentration of ammonia found in their samples to determine the quality of the water. In aquatic environments, such as a pond, the concentration of ammonia is considered safe between 0.02 and 0.4 mg/L.

Equipment

For the class	For each student
• 4 VISOCOLOR SCHOOL reagent cases - Water analysis • 4 stopwatches • Litmus test strips	• Lab coats • Gloves • Eyewear • Science journal • Pencils

Session 1 – Laboratory Rotation 1

Lesson Steps

1. Students are to be organised into their four groups per the Water Collection Excursion; Red, Blue, Green and Yellow.
2. Students are told that they will be testing their pond water samples to measure four different compounds (abiotic factors affecting the quality of) in the water. Results are to be recorded in their Science journals.
3. The testing kit is introduced and demonstrated using a sample of drinkable water. The teacher explains to the students that they are going to be testing for PH, ammonium, phosphate and nitrate, and how to read and follow the instruction manuals themselves.
4. Instructions are provided in how to test for PH using litmus test strips as well.

5. Students are told that each table has a testing kit in front of them where each student in the group participates in, at least one of, the steps to measure the quality of water. A stopwatch can be used for the timer during the experiment.
6. After the experiment has concluded, the students are asked to record their results under the subtitles 'PH testing of Pond Water/Ammonium testing of Pond Water/Phosphate testing of Pond Water/Nitrate testing of Pond Water' on the 'Results' page, depending on what they're testing at that particular table (Appendix A)
7. In the second half of the session, students are asked to switch with the other group behind/in front of them, to test another compound.
8. **Reflection**: After all experiments are concluded, two by each group, they are asked to think-pair-share in their groups and reflect for five minutes and keep in mind those thoughts for discussion at the end of the second session.
    - ❖ Guiding questions:
        - Does today's activity change your thoughts on measuring water quality?
        - How would your answer today be different to our first lesson? When we spoke about judging the quality of the water samples provided.
        - Can we truly be right judging the quality of water simply by how it 'looks'?

Session 2 – Laboratory Rotation 2

Lesson Steps

1. Students are told to regroup to be in their groups to continue the experimental activities. Students are advised that they will be given a shorter timeframe as they already know what to do.
2. Students are told to repeat the same process as session one except, this time, they conduct experiments for the two compounds they did not test for in the first session.
3. Students swap during the halfway time mark of the session to conclude all experiments.
4. **Reflection** - Students are to come to the floor with their results and reflect on their answers from the end of session one. Students are to share anything interesting they thought they did/found during the four experiments.
5. Students are asked what kind of factors the compounds represent when describing the quality of water (*they should be able to recall the term 'abiotic' at this point*).
6. Students are de-briefed on how they will graph their results in a bar chart and compare it against the good quality water benchmark graph on the whiteboard. Students will then, link the practical experiments to the content knowledge together as a class and begin to truly unpack the interpretations of their results.

Alignment with Victorian Curriculum

Science

- Decide which variables should be changed, measured and controlled in fair tests and accurately observe, measure and record data (VCSIS084)

Critical and Creative Thinking

- Investigate a range of problem-solving strategies, including brainstorming, identifying, comparing and selecting options, and developing and testing hypotheses (VCCCTM020)

Appendices

Appendix A: Student Water Quality Guides

Phosphate

Water Quality	Excellent	Good	OK	Poor
mgP/L	<0.01	0.011 – 0.025	0.026 – 0.1	>0.1

Nitrate

Water Quality	Excellent	Good	OK	Poor
mg/L	0	10-25	50-250	500

pH

Water Quality	Excellent	Good	OK	Poor
pH	6.5-7.5	7.6-8.0	8.1-9.0	>9

Ammonia

Water Quality	Excellent	Good	OK	Poor
ml/L	0-0.01	0.01-0.02	0.03	>0.03

Lesson 5: Analysing Water Quality Results – Graph It!

Aims of the Stage

During this stage, students will show reasoning and critical thinking when explaining their findings from the pond excursion.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- Identify and explain the impact of the presence of varying amounts of ammonium, phosphate, nitrate, and pH in water
- Make comparisons of results from the pond water lab testing against the benchmarks of drinkable water quality
- Graph, interpret and share findings from the water quality charts

Assessment Focus

Formative Assessment
In this lesson, students' developing understanding of basic chemicals found in water will be monitored. They will be given recursive feedback that aims to extend their learning. The students' science inquiry skills will also be assessed.

Teacher Background Information

The practice of making water safe for drinking involves adding a number of chemicals to it. Tap water is treated with many chemicals in order to kill bacteria and other microorganisms, making it safe to drink. However, it is not certain that these chemicals are entirely safe to ingest and may cause some health concerns in the long-term. Some of the chemicals that are added to the water supply include:

- Chlorine
- Fluorosilicic acid
- Aluminium sulphate
- Calcium hydroxide
- Sodium silicofluoride

Even though pond water is not intended for drinking, it is still important to control the level of harmful chemicals that enter the water, as the aquatic ecosystem is dependent on the quality of

the water to grow and reproduce.

Nitrogen and phosphorus are nutrients that are important, but excess concentrations may cause increased growth of plants and algae. Nitrate concentrations over 3 mg/L and phosphorus concentration above 0.025 mg/L reduces the quality of the water and is considered harmful for the aquatic ecosystem.

The concentration of pH in a pond should be maintained between 6.0 and 9.0, and anything less is considered very low water quality and will result in reduced or absent fish populations.

If ammonia is present in high levels of concentration in the water, it indicates that the water does not have sufficient oxygen to oxidize ammonia to nitrate and nitrite. Plant and algae growth are promoted when suitable concentrations of both nitrate and pH are found in water at the same time as sufficient phosphate levels. However, abnormal concentrations of ammonia limit this process, affecting the entire pond's ecosystem. Concentrations of ammonia below 0.3 ml/L is considered low and will limit plant and algae populations. Ammonia can be toxic to fish and other animals, which also depends on the concentration of other influences such as pH and temperature.

Students will be able to measure these nutrients found in their samples of pond water. By comparing the concentration levels of each compound, and how each compound interacts with one another to affect the water, students will be able to make assumptions on the quality of the water and whether it is considered safe for the aquatic ecosystem.

Equipment

For the class	For each student
• Class Water Quality Bar Graphs • Coloured paper	• Science journal

Lesson Steps

1. Review the students' science journal with the laboratory test results.
2. Instruct students to sit in with their laboratory groups. Each group will be given small pieces of coloured paper to write their results in.
3. A bar graph base will be drawn on the white board -- with the categories: pH testing of Pond Water, Ammonium testing of Pond Water, Phosphate testing of Pond Water, Nitrate testing of Pond Water. The benchmarks for drinkable water will already be graphed as reference for then students.
4. Explain that students are going to organise their information in a graph as a class.

5. Instruct the students to write their Ammonium testing result on the piece of paper. Model an example of where a result goes in the graph.
   Note: The vertical axis is used to plot the units of measurement while the horizontal axis is used to plot the categories of information.
   Discuss the purpose and features of a bar graph (Appendix A)
6. Have one student from each group post their result on the bar graph next to the benchmark bars.
7. Repeat steps 4 and 5 for the rest of the graphs.
8. Direct instruction – Explain the following important ideas to the students:
   a. **Nitrate** concentrations over 3 mg/L and **phosphorus** concentration above 0.025 mg/L reduces the quality of the water and is considered harmful for the aquatic ecosystem.
   b. The concentration of **pH** in a pond should be maintained between 6.0 and 9.0, and anything less is considered very low water quality and will result in reduced or absent fish populations.
   c. If **ammonia** is present in high levels of concentration in the water, it indicates that the water does not have sufficient oxygen to oxidize ammonia to nitrate and nitrite.
9. From the information presented, instruct the students to do a Think-Pair-Share. Ask the following to be discussed with a partner:
   - ❖ Guiding questions:
     - What is your result for nitrate testing? What does this mean for the animals living in the pond? Phosphorus? pH? Ammonia?
10. Ask the students their answers to class. Afterwards, instruct them to record their statements on their science journal.
11. **Reflection -** As a class, students reflect on 3 points they think they need to remember about water quality, 2 things they liked in the activities so far, and 1 question they still have regarding water quality.

Alignment with Victorian Curriculum

Science

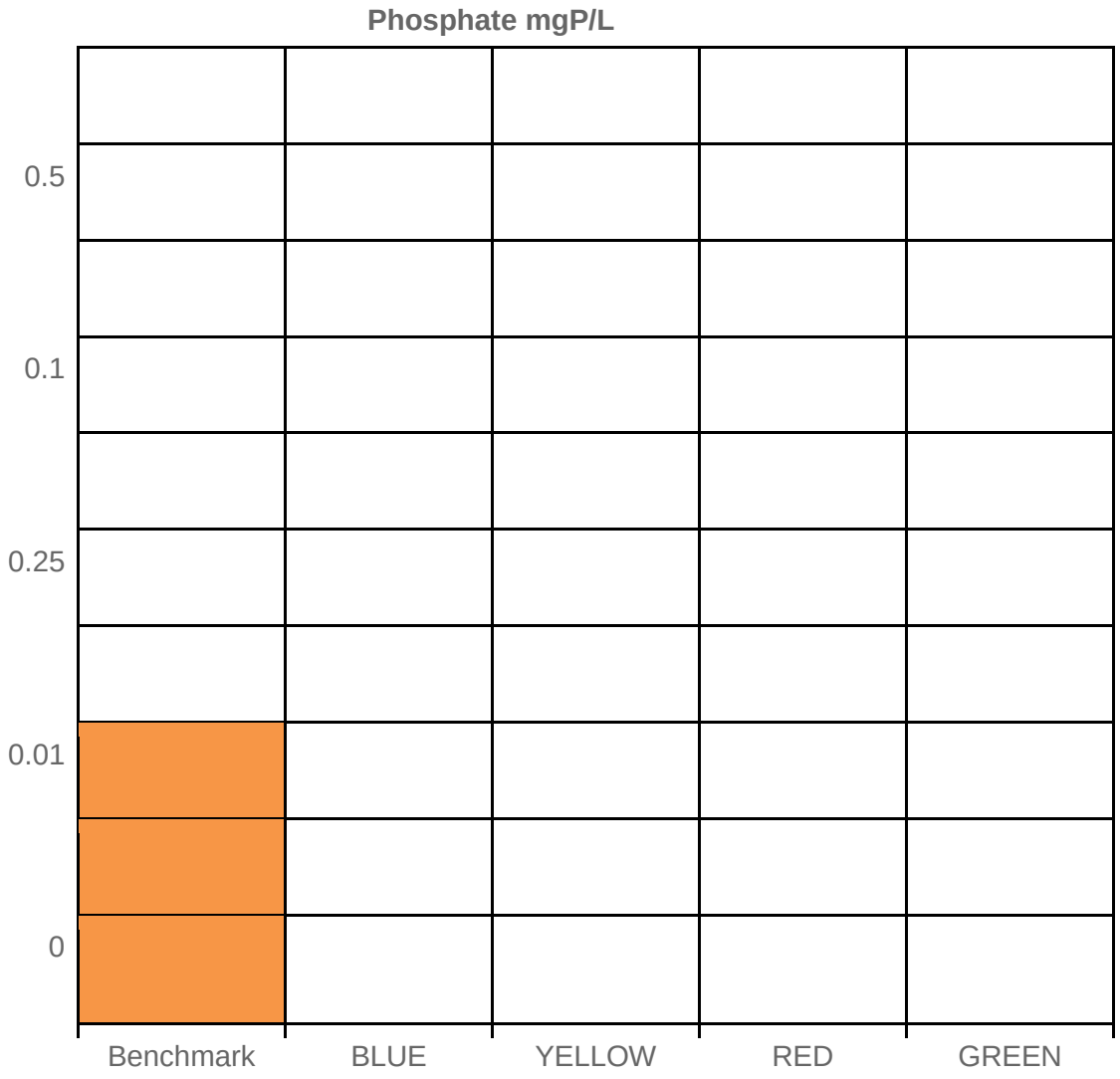
- Construct and use a range of representations, including tables and graphs, to record, represent and describe observations, patterns or relationships in data (VCSIS085)
- Compare data with predictions and use as evidence in developing explanations (VCSIS086)
- Suggest improvements to the methods used to investigate a question or solve a problem (VCSIS087)

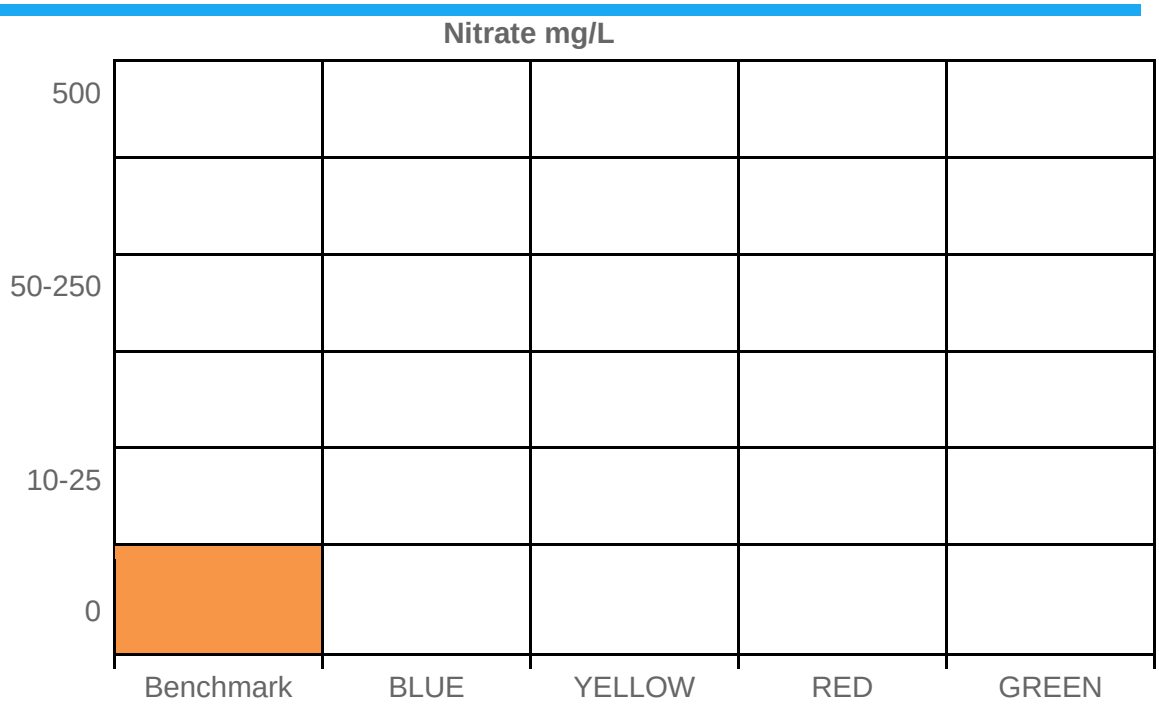
Critical and Creative Thinking

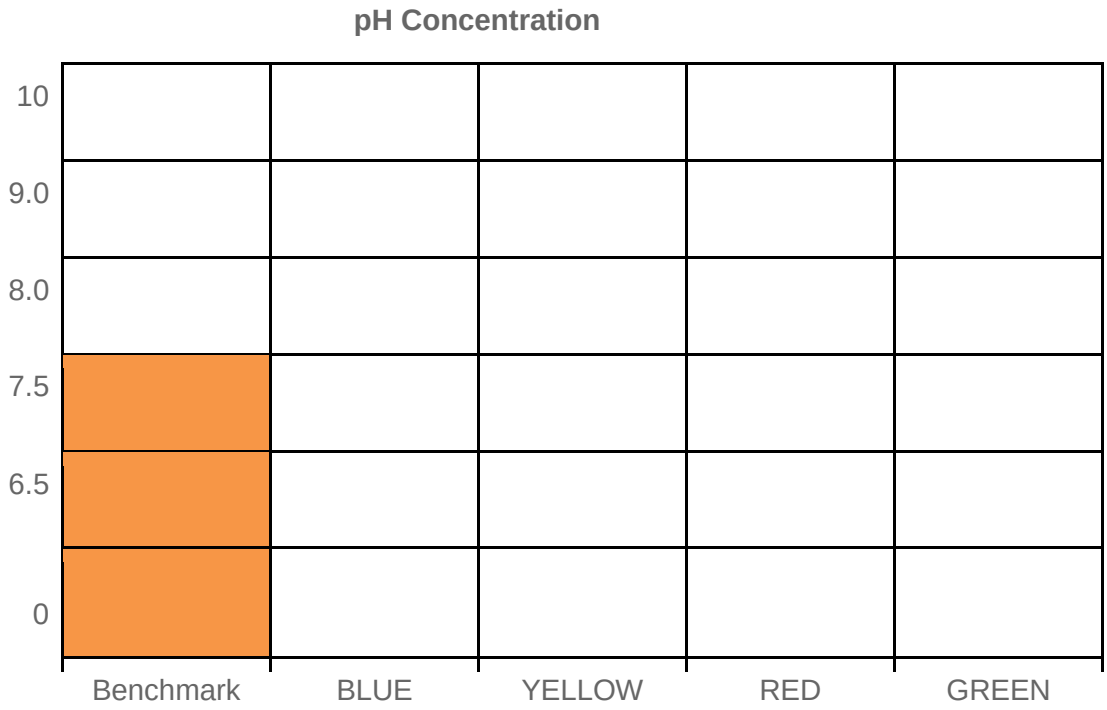
- Investigate thinking processes using visual models and language strategies (VCCCTM029)

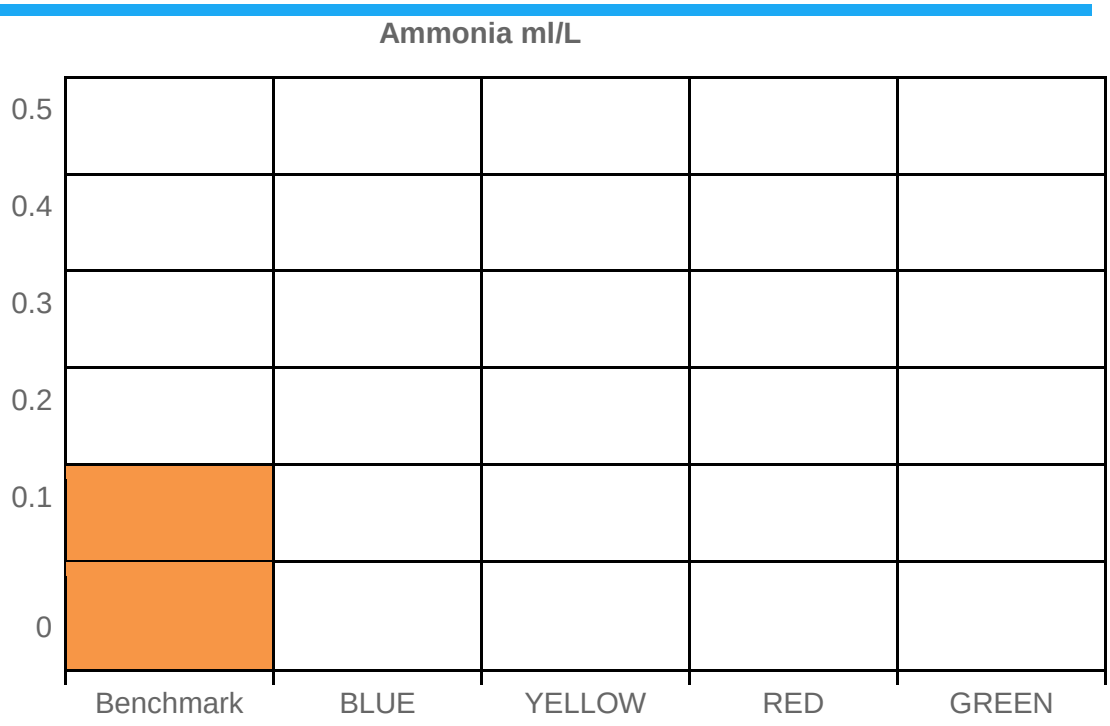
Appendices

Appendix A: Bar Charts




Nitrate mg/L
500
50-250
10-25
0
Benchmark
BLUE
YELLOW
RED
GREEN


pH Concentration
10
9.0
8.0
7.5
6.5
0
Benchmark
BLUE
YELLOW
RED
GREEN


Ammonia ml/L
0.5
0.4
0.3
0.2
0.1
0
Benchmark
BLUE
YELLOW
RED
GREEN

Lesson 6: Community Water Use

Aims of the Stage

In this stage students will elaborate on their learning by brainstorming their findings from the pond excursion. Students will practice metacognitive skills through reflection about the ethical implications of their findings.

Learning Outcomes

The students will be able to demonstrate knowledge and understanding as they:

- Investigate factors that affect water quality
- Brainstorm about every day and community water use affecting water quality
- Reflect on ethical implications that affect the quality of water and its consequences to the community and to the planet
- Reflect on learning throughout the unit

Assessment Focus

Summative Assessment
In this lesson, evidence of the students' overall understanding and knowledge of water quality and its impact to the community and to the planet will be monitored and assessed.

Teacher Background Information

Victoria has many streams of water such as rivers, wetlands, bays and coasts that sustain the population and the future, while also being the home to many living organisms. Human impact, either directly or indirectly, through everyday activities have an impact on the quality of water. In urban areas throughout Melbourne, and an increase of production and consumption activities has led to an increase in pollution.

With increased urbanisation, the water entering waterways from hard surfaces or drains can have a negative impact on the aquatic habitat. During rainfall, stormwater flows into water stream carrying high levels of nutrients, sediment and heavy metals, leading to vast changes in water quality levels and affecting aquatic environments. According to the Australian Government Initiative (2019), some of the effects we see in urbanised areas such as Melbourne on these water environments include:

- Outbreak of invasive aquatic species
- Smothering of aquatic plants
- Toxicity to aquatic organisms
- Promotion of algae blooms and other contamination issues

Bushfires are natural disasters that occur throughout Victoria, which negatively impact the quality of water. Bushfires alter the soil structure and result in the loss of vegetation, ultimately increasing the risk of sediments and pollutants entering the waterways through runoff. Not only does this impact the water for population use such as drinking water and water for agricultural activities, but it also negatively affects the aquatic ecosystems.

In a recent event in Melbourne's West, a factory caught on fire, having detrimental effects on the waterways surrounding the factory. Clouds of toxic smoke as well as toxic waste from the fire had entered the waterways through runoff, contaminating the water in many areas throughout Melbourne (Hinchliffe 2018). The aquatic habitat was affected, killing many species in the water as water quality dropped to harmful levels.

Being aware of how human and environmental doings impact our waterways are important for students recognise. There are many measures that individuals can implement in their daily lives to manage the way we impact the environment and the waterways. The runoff of water containing harmful chemicals affects the quality of water in many ways, and students will understand that the compounds found in water such as nitrate, phosphate, ammonium and PH are able to be examined to determine the length of the impact it has on the water and the ecosystem as a whole.

Equipment

For the class	For each student
● 'Eliza goes to the Beach' fiction script ● Question sheet	● Science journal

Lesson Steps

1. Recap the differences between abiotic and biotic factors that influence pond water.
    - ❖ Guided Questions:
        - What 4 abiotic factors did we test for in the prior lesson?
        - Why are each of these factors important to test the quality of pond water?
        - What factors did we find interesting when testing pond quality?
        - How do we think humans can affect this pond water?
        - Do you think our actions affects pond water?
2. Students are provided with 'Eliza goes to the Beach' narrative (Appendix A).
3. Request that students read through the text once and identify what type of text it is
    - ❖ Guided Questions:
        - What clues does the text provide us with to tell us that this is a fiction text?

4. Students are then asked to read through the text again and highlight abiotic or biotic factors that may influence the quality of water.
5. Students answer the text questions (Appendix B)
6. **Reflection** - students come to the floor and discuss their overall experience regarding the unit of work. The 'Wonder Wall' is used as a prompt for guiding questions.
    - ❖ Guiding Questions:
        - What is the difference between abiotic and biotic factors?
        - What abiotic factors were tested for water quality in ponds?
        - Who can tell me some features of the abiotic factor we have learned during this unit of work and how they affect the quality of water?
        - What are some ethical issues faced in the community?
        - How can we better our actions to foster good quality water for our Earth?
        - Did you like this unit of work? Do you have any suggestions for how we can improve this unit of work and what we can do differently for the next one?

Alignment with Victorian Curriculum

Science

- Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships (VCSIS088)

English

- Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences, and present and justify a point of view or recount an experience using interaction skills (VCELY337)

Critical and Creative Thinking

- Identify and form links and patterns from multiple information sources to generate non-routine ideas and possibilities (VCCCTQ023)

Appendices

Appendix A: Written Sample Text

Eliza goes to the Murray River

One Sunday afternoon, Eliza went to the park surrounding Murray River with her dad and dog (Tizzy) for a picnic. Eliza loves to sit and watch the ducks swimming in the river. While walking through the paths to find a place to set up their picnic, Eliza and her dad spotted a farmer using some of the water to clean his fish tank. The farmer then tipped the water back into the river. She immediately asked her dad, "Is it alright for the ducks to drink this water?". Her dad answered, "no, not really. It is actually quite harmful". Eliza sighed in confusion and continued to walk with her dad.

While her dad was setting up the picnic, naughty Tizzy quickly ran and peed into the river. The dog kept running around while Eliza and her dad enjoyed some sandwiches, fruits and juice. With the sky turning grey, a strong wind blew the sandwich bags and Eliza's half-drunk juice box into the river where she saw them floating.

Worried about the rain, Eliza's dad packed the picnic basket quickly and rushed Eliza and Tizzy back to the car. Eliza turned around and suddenly saw that everyone around at the park was littering and being ignorant of the effects of littering. She thought to herself, what once was a beautiful, green river and a happy home for the ducks and fish, now seemed like a dull, grey pool of water.

Appendix B: Question Sheet

According to the story, what do you think can impact the quality of the water in the river?

What are some other human actions you can think of, that will contaminate the quality of water?

Name 2 abiotic factors used to measure the quality of water. What results can you expect for those factors in river water?

Name of abiotic factor/compound	River
1.	
2.	

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Summary of Contributions

Our Water Quality team met 5 times to discuss the preparation of the lesson sequence as well as establish lesson plans that were sequential, engaging and related to the Science Curriculum for Year 5. Throughout these meetings, notes were taken by Sashmi Dunusinghe in order to compile information, discussions and team decisions.

- *Meeting 1:* Discussed various topics of interest to base the lesson sequence on.
- *Meeting 2:* By the second meeting that the topic would be Abiotic factors that affect Water quality in water bodies.
- *Meeting 3:* Our third meeting was conducted in the lab in which a water quality kit was presented to us with information on how to test and why to test the quality of water. As a team we spent the meeting using the water testing kits and establishing a lesson structure that would cater for the learning outcomes discussed. We agreed on the 5E's Instructional model to be used throughout the sequence and to structure the lessons over 6 lesson plans.
- *Meeting 4:* indicated the plan for each lesson and discussed delegation of work and lesson structure based on working to the abilities of each team member.
- *Meeting 5:* included finalisation of the lessons establish as well as discussion on preparing for the presentation and allocation of speakers during the presentation.

Based on these discussions and teamwork ideas the following contributions were made by each teach member.

I. Executive Summary

Written and edited by *Danielle Alves, Airom Camua, Olympia Christodoulides and Sashmi Dunusinghe*

Executive summary was a combination of all group member teamwork and was established from the unit of work itself.

O*verview* was a brief understanding of the pedagogical theory applied throughout the lesson sequence and agreed upon by all team members that the 5E approach will applied for this unit of work (summarised by Olympia Christodoulides and Danielle Alves).

Victorian Curriculum content descriptors were based on the team agreeing to which year level the lesson sequence was aimed towards; this was compiled by Airom Camua once establishment of the Year 4 curriculum was confirmed.

Unit at a glance is a brief overview of each lesson which was structured together to create a sequence that was engaging and catered for the overall lesson outcomes and

had a sequential flow. This was developed through each team meeting and compiled together by Sashmi Dunusinghe.

II. Lesson 1: Wondering about Water

Written and edited by *all team members*

The lesson itself was created through teamwork and exploring ways in which student engagement into the topic would be fulfilled.

- Danielle Alves - 'Aims of the Stage' and 'Alignment with the Victorian Curriculum'
- Airom Camua - 'Lesson Steps', ''Learning Outcome', Assessment Focus and 'Appendices'
- Olympia Christodoulides - 'Teacher Background - Excursion Preparation' as well as full edit of the lesson to ensure flow throughout the document.
- Sashmi Dunusinghe - Edit of the lesson to ensure flow throughout the document.
- John Stojevski - 'Teacher Background Information'

III. Lesson 2: Planning and Preparation

Written and edited by *all team members*

- Danielle Alves - 'Aims of the Stage' and 'Alignment with the Victorian Curriculum'
- Airom Camua - 'Learning Outcome' and 'Assessment Focus'
- Olympia Christodoulides - 'Equipment, ''Lesson Steps' and 'Appendices'
- Sashmi Dunusinghe - Edit of Lesson to ensure flow throughout the document and 'Teacher Background Information'
- John Stojevski - 'Teacher Background Information'

IV. Lesson 3: Pond Excursion

Written and edited by *all team members*

- Danielle Alves - 'Aims of the Stage' and 'Alignment with the Victorian Curriculum'
- Airom Camua - 'Learning Outcome', 'Assessment Focus' and 'Appendices'
- Olympia Christodoulides - 'Equipment, ''Lesson Steps'
- Sashmi Dunusinghe - Edit of Lesson to ensure flow throughout the document.
- John Stojevski - 'Teacher Background Information'

IV. Lesson 4: Water Quality Detectives

Written and edited by *all team members*

- Danielle Alves - 'Aims of the Stage' and 'Alignment with the Victorian Curriculum'
- Airom Camua - 'Learning Outcome' and 'Assessment Focus'
- Olympia Christodoulides - Edit of Lesson to ensure flow throughout the document.

- Sashmi Dunusinghe - ‘Equipment’ and ‘Lesson Steps’
- John Stojevski - ‘Teacher Background Information’

V. Lesson 5: Water Quality Researches

Written and edited by *all team members*

- Danielle Alves - ‘Aims of the Stage’ and ‘Alignment with the Victorian Curriculum’
- Airom Camua - ‘Learning Outcome’ and ‘Assessment Focus’
- Olympia Christodoulides - Edit of Lesson to ensure flow throughout the document.
- Sashmi Dunusinghe - ‘Equipment’ and ‘Lesson Steps’
- John Stojevski - ‘Teacher Background Information’

VI: Lesson 6: Community Water Use

Written and edited by *all team members*

- Danielle Alves - ‘Aims of the Stage’ and ‘Alignment with the Victorian Curriculum’
- Airom Camua - ‘Learning Outcome’ and ‘Assessment Focus’
- Olympia Christodoulides - ‘Equipment’ and ‘Lesson Steps’ and edit of Lesson to ensure flow throughout the document.
- Sashmi Dunusinghe - ‘Appendices’ and ‘Lesson Steps’
- John Stojevski - ‘Teacher Background Information’

VII: Other

Summary of Contributions: complied by Olympia Christodoulides

Final formatting: Airom Camua, Olympia Christodoulides and Sashmi Dunusinghe

Presentation Slides: Sashmi Dunusinghe and overview by all team members.