 Module 1 - Role of Observations

Year 11 – Investigating science 2018

This document references the [Investigating Science Stage 6 Syllabus](https://syllabus.nesa.nsw.edu.au/investigating-science-stage6/) © 2017 NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales.

Inquiry Question: How does observation instigate scientific investigation?

Duration: 6-7 hours

Rationale

Observation instigates all scientific experimentation. Investigative scientific processes can only be applied to phenomena that can be observed and measured. Detailed observations motivate scientists to ask questions about the causes and the effects of phenomena they observe. In this way, science continues to progress and enhance the lives of individuals and society by encouraging a continued search for reason and understanding.

Working scientifically

In this module, students focus on developing hypotheses that arise from their observations and evaluate these in order to gather, select and process appropriate qualitative and quantitative data. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Depth study:

Outcomes

A student:

* INS11/12-1 develops and evaluates questions and hypotheses for scientific investigation (WS1)
* INS11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information (WS3)
* INS11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media (WS4)
* INS11-12-6 solves scientific problems using primary and secondary data, critical thinking skills and scientific processes (WS6)
* INS11/12-7 communicates scientific understanding using suitable language and terminology for a specific audience or purpose (WS7)
* INS11-8 identifies that the collection of primary and secondary data initiates scientific investigations

References the Working Scientifically outcomes are abbreviated (in brackets) in the sample unit of work after each skill descriptor.

Assessment

| Outcomes/content | Teaching and learning | Evidence of learning | Registration |
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| Students:* carry out a practical investigation to record both quantitative and qualitative data from observations, for example:
	+ burning a candle floating in a closed container
	+ the behaviour of slaters in a dry/wet or light/dark environment
	+ the Bernoulli effect
	+ strata in rock cuttings
* develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data
* employ and evaluate safe work practices and manage risks (WS3)
* select qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media (WS4)
* apply quantitative processes where appropriate (WS4)
 | First lesson should engage. Some minor organisation required prior to lesson. Set up several stations with simple practical activities to conduct observations. Students should be able to carry out each practical within the given stations. Simple experiments that have possibly been carried out in Stage 4-5 work well. For example:* Vinegar and bicarb
* Limewater and straw
* Burning candle (floating in closed container)
* Newton’s cradle
* Electrical circuit with switch
* Iodine solution and bread
* Ray box with prism
* Pop test using magnesium + HCl
* Laminated pictures of various images (strata in rocks, etc.)
* Walk outside to investigate an ant’s nest, a garden, weed growth, etc.
* [Bernoulli effect](https://www.youtube.com/watch?v=1JuoSJz3SRU)

Class discussion on Observations. What are they? How good are we at observing?* Watch the following video on YouTube “[Observation & Inference Whodunit](https://www.youtube.com/watch?v=X7V_vaY9Bdk)” to see how good we really are at observing: https://www.youtube.com/watch?v=X7V\_vaY9Bdk
* [observe a photo for 30 seconds](http://www.shodor.org/succeed-1.0/forensic/observation/observation.html) and then answer 10 quick questions to test their observation skills. http://www.shodor.org/succeed-1.0/forensic/observation/observation.html
* record observations when burning candles of different colours, brands, sizes or burning different fuels
* be a forensic investigator for a given scenario in a simulated crime scene, and solve using forensic science techniques and methods or [use the real csi](https://education.abc.net.au/home#!/topic/495138/forensic-science) http://splash.abc.net.au/home#!/digibook/965439/the-real-csi to discuss the importance of observing accurately

What is an Observation?Define an observation as using the 5 senses. In Science, an “observation” is any information you can gather using the five senses and scientific instruments and tools. In other words, what can we actually see, smell, taste, touch, hear, and measure. Go back to the initial experiments and categorise the observations the students made under senses and/or measurements.How else can we observe in Science? Draw a mind map with “Observations” in the middle. Starting with the 5 senses and add the following scientific observation tools that can make many more observations much more precisely than those our basic senses are equipped to handle (if the students don’t come up with them):* Extending senses (vision/hearing) - microscopes, telescopes, scanners, videos, hi-res photos, radio transmitters, radar, deep sea submarines, etc.
* Phenomenon not directly observable - radiation (Geiger counter) or pH, etc.
* Medical – X-Rays, CAT scans, etc.
* Time
* Temperature
* Weight

Why do we need to observe in Science?[Learning to see](https://www.sciencelearn.org.nz/resources/1400-observation-learning-to-see) https://www.sciencelearn.org.nz/resources/1400-observation-learning-to-seeDefine qualitative and quantitative observations and give examples:PictureQualitative Observations:(descriptive characteristics)* The tomatoes are red.
* The tomatoes are round.
* The tomatoes reflect light.
* The tomatoes have a green vine.

Quantitative Observations:(measurable quantities)* The tomatoes have a mass of 15.5 grams.
* There are three tomatoes.
* There are three stems.
* There is one vine.

Give students a list of observations and get them to determine if they are qualitative or quantitative. A Kahoot! Game would be ideal here. | * Using a simple table, students write down any observations they encounter for each experiment
* Get the students to check each other’s lists to ensure they contain only observations and not inferences
* Modify the table above to list observations under senses and measurements – repeat experiments if needed
* Modify the table again to list observations for each experiment under qualitative or quantitative – repeat experiments if needed.
* Discuss what would be needed to improve the quantitative observations.
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| Students:* discuss and evaluate the characteristics of observations made compared to inferences drawn in respect of the practical investigation
* use scientific evidence and critical thinking skills to solve problems (WS6)
 | Observation vs InferenceDefinitions: Inferences are explanations or interpretations of what you are observing. They are statements that explain what you are observing.Process of Inferring* Observe an object, event, or situation. Gather information through experimentation or observation. Think about what you already know and what you find. Look at your results and compare them to what you previously thought.

Utilise some simple examples with students:PictureLook at the picture of the rainbow above. What can we infer from looking at this picture?Possible inferences include:* It just finished raining or still may be raining.
* The sun will come out and it has finished raining for the day
* It was thunder storming earlier.

Why do we need to observe in Science?[Learning to see](https://www.sciencelearn.org.nz/resources/1400-observation-learning-to-see) https://www.sciencelearn.org.nz/resources/1400-observation-learning-to-see Good [introduction activity](https://www.nh.gov/nhdhr/programs/documents/boyinthewater.pdf) for lower ability students: https://www.nh.gov/nhdhr/programs/documents/boyinthewater.pdfSummaryGreat summary of [Observation vs Inference](https://www.youtube.com/watch?v=IFQLDcBVReQ) https://www.youtube.com/watch?v=IFQLDcBVReQFun Activity: Watch an episode of “Brain Games” on ClickView. What we see is not always what is happening.Some very simple/fun practical/[activity ideas to show observation vs inference](http://www.teacherlink.org/content/science/class_examples/Bflypages/timlinepages/nosactivities.htm): http://www.teacherlink.org/content/science/class\_examples/Bflypages/timlinepages/nosactivities.htm | * Refer to the original experiments and tabulate the inferences that could occur based on the observations noted.
* Observations as evidence for inferences – produce and display a concept map linking observations made in a chosen area with possible inferences that could result from the observations made.
* Get students to complete a Practical report on an experiment they have not encountered.
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| Students:* research how observation has instigated experimentation to investigate cause and effect in historical examples, including but not limited to:
	+ Archimedes observing the displacement of water
	+ Alexander Fleming’s observations of the effect of mould on bacteria
	+ Galileo’s observations of the movement of Jupiter’s moons
* select and use suitable forms of digital, visual, written and/or oral forms of communication (WS7)
 | Students are involved in active research and given a scenario for one of the scientists in the list. Teachers and students may choose to research another scientist after having studied Archimedes, Fleming and Galileo.Pretend you are Archimedes. What instructions would you give for comparing the density of a crown with the density of gold? Students communicate their understanding in a number of ways. Archimedes, one of the most famous mathematicians and scientists of ancient Greece, had a problem. The king had a new crown. It looked like pure gold. But the king was suspicious. How could he be sure that the jeweller hadn’t cheated him by adding another, less valuable metal to the molten gold? The king asked Archimedes to find out whether the crown was made from pure gold.Alexander Fleming:Students should review [this resource](https://www.acs.org/content/dam/acsorg/education/whatischemistry/landmarks/flemingpenicillin/the-discovery-and-development-of-penicillin-commemorative-booklet.pdf): https://www.acs.org/content/dam/acsorg/education/whatischemistry/landmarks/flemingpenicillin/the-discovery-and-development-of-penicillin-commemorative-booklet.pdfGalileo:[Astronomy differs from most sciences](https://www.atnf.csiro.au/outreach/education/senior/astrophysics/galileo.html) is that it is primarily observational rather than experimental. https://www.atnf.csiro.au/outreach/education/senior/astrophysics/galileo.html“The Story of Science: Power, Proof and Passion” is a 2010 BBC documentary on the history of science presented by Michael Mosley. This is a fantastic visual resource for this historical content.Episode 1: What Is Out There?Episode 2: What is the World Made of? | * Observations as evidence for inferences – produce and display a concept map linking observations made in a chosen area with possible inferences that could result from the observations made.
* Have students summarise their understanding by clearly listing only the observations that each scientist made.
* What inferences did this then lead to?
* What cause and effect experiments were instigated from their observations?
* Students can create a cause and effect diagram for each scientist.
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| Students:* assess ways in which Aboriginal and Torres Strait Islander Peoples use observation to develop an understanding of Country and Place in order to create innovative ways of managing the natural environment, including but not limited to:
	+ firestick farming
	+ knowledge about plants for medicinal purposes
* select and use suitable forms of digital, visual, written and/or oral forms of communication (WS7)
 | Australian Aboriginal people have lived in Australia for at least 40,000 years, and in all those long generations the land provided them with everything they needed for a healthy life. They also learned to manage their country in such ways that its resources renewed themselves and were not used up. * Define what is meant by Country and Place to Aboriginal People

Fire stick farming:Aboriginal people created a complex system of land management. There was no ‘pristine wilderness’, rather a patchwork of burnt and re-grown areas. Fire was their biggest ally. In using fire Aboriginal people could plan and predict plant growth and with it attract animals for hunting. They converted the land to grasslands for the “maintenance” of animals, plants and fresh drinking water.Watch the video by Bill Gammage as he discusses how Aboriginal people managed country: * [Biggest Estate on Earth](https://www.youtube.com/watch?v=Sko-YDIULKY) https://www.youtube.com/watch?v=Sko-YDIULKY
* [Land care](https://www.creativespirits.info/aboriginalculture/land/aboriginal-land-care#toc1) https://www.creativespirits.info/aboriginalculture/land/aboriginal-land-care#toc1
* [Management of the Savanna](http://splash.abc.net.au/home#!/media/29925/management-of-the-northern-savanna) http://splash.abc.net.au/home#!/media/29925/management-of-the-northern-savanna

Plants for medicinal purposes:[South Eastern Australian plant use](https://parksaustralia.gov.au/botanic-gardens/pub/aboriginal-plantuse.pdf) https://parksaustralia.gov.au/botanic-gardens/pub/aboriginal-plantuse.pdfVisit the Australian National Botanical Gardens website to investigate Aboriginal Plant Use:* [Aboriginal Plant use trail](http://www.anbg.gov.au/gardens/visiting/exploring/aboriginal-trail/index.html) http://www.anbg.gov.au/gardens/visiting/exploring/aboriginal-trail/index.html
* [Aboriginal bush medicines](https://www.anbg.gov.au/gardens/education/programs/pdfs/aboriginal-bush-medicines.pdf) https://www.anbg.gov.au/gardens/education/programs/pdfs/aboriginal-bush-medicines.pdf

Students investigate how Aboriginal and Torres Strait Islander people identified and used plants for eating and medicinal purposes. With the assistance of a local Indigenous guide, students could explore plants which are native to the local area. Students could learn about the ways in which Aboriginal and Torres Strait Islander people value and protect the Earth’s natural resources.Other ways that Aboriginal and Torres Strait Islander Peoples use observation to develop an understanding of Country and Place to create innovative ways of managing the natural environment:* Indigenous knowledge of places, spiritual connections and the complex relationships with these places are demonstrated in a variety of practices as well as firestick farming and plants for medicinal uses; including seasonal calendars, collection of bush tucker and fish trapping.
* Sustainable environmental practices have developed over time and assist in the management of resources and the conservation and protection of animal and plant life, communities and mineral resources. Uranium in the Northern Territory is an example of this.

Support student research by inviting an Aboriginal Education consultant, Aboriginal cultural educator or appropriate knowledge holder to come and show or discuss these practices with students.Key ConsiderationsAccess to Aboriginal Education consultant, Aboriginal cultural educator or appropriate knowledge holder able to discuss the practices of Aboriginal and/or Torres Strait Islander Peoples relating to observations and inferences and biases of European settlers on Aboriginal People’s ecological understanding and practices.Depth Study Examples:[Example activities and courses](https://serc.carleton.edu/sp/process_of_science/browse_examples.html) https://serc.carleton.edu/sp/process\_of\_science/browse\_examples.html | * Summarise or draw a series of illustrations to document the observations that the Aboriginal people made that enabled them to farm the way they did.
* Students should tabulate the list of plants used for medicinal purposes.
* Will looking back at the practices of the Aboriginal and Torres Strait Islander people allow us to have a sustainable future?
* Use a catastrophic event such as the 2003 bushfires to show how the use of traditional practices and working systems may prove to be the best strategy for managing current situations.

Assessment for learning* Students prepare a response to the following question: Describe how Aboriginal and Torres Strait Islander Peoples have used observations and inferences to utilise the natural resources available to them.
* Feedback is provided to students.
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Reflection and evaluation:

| Questions | Answers |
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| What worked well? |       |
| What needed improving? |       |
| New resources and ideas? |       |
| Registration: | Date commenced:      Date completed:       |