 Module 1 - Observations

Year 11 - Investigating science 2018

Duration: 4-6 hours

Description of unit

Observations instigate all scientific experimentation. Detailed observations form the basis of scientific investigations and allow scientists to identify patterns, describe relationships, make conclusions and connect cause and effect. This leads to scientists asking questions that can be investigated to give us a better understanding of our world. Students explore the importance of quantitative and qualitative observations and the roles that each play in scientific discovery. They describe quantitative and qualitative observations in a variety of investigations and evaluate the differences between them.

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

What are the benefits and drawbacks of quantitative and qualitative observations?

Please note that Working Scientifically outcomes in the sample unit of work are represented with the letters WS to differentiate from the content descriptors.

Working Scientifically Outcomes

Students conduct practical investigations safely and make detailed observations. They identify these observations as quantitative or qualitative and describe the benefits and drawbacks of each type of observation. Students record and analyse quantitative data collected using tables, graphs, diagrams and digital technologies. Students evaluate the differences between quantitative and qualitative observations and data as well as describe examples of where they are best used in investigations.

A student:

* INS11/12-1 develops and evaluates questions and hypotheses for scientific investigation
* INS11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information
* INS11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* INS11/12-5 analyses and evaluates primary and secondary data and information
* INS11-8 identifies that the collection of primary and secondary data initiates scientific investigations

Assessment

Formative assessment can be used through the unit to gauge understanding and direct teaching and learning.

| Outcomes/content | Teaching and learning | Evidence of learning |
| --- | --- | --- |
| Students:   * carry out a practical activity to quantitatively and qualitatively describe, for example:   + microscopic images of a variety of cells   + geological strata in rock faces and road cuttings   + an object falling due to gravity   + characteristics of acids and bases   WS INS11/12-1   * + develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data decorative | Engage  Watch the [interview with Neil deGrasse Tyson, astrophysicist, on ABC Lateline](http://www.abc.net.au/lateline/content/2016/s4681600.htm) 06/06/2017 and discuss the importance of observations in science, how we collect scientific information and how observations rely on tools and technologies available. http://www.abc.net.au/lateline/content/2016/s4681600.htm  ‘It is the observations that matter. Even if they conflict with what feels right to you, we have learnt to trust the observations because that is a measure of reality.’ Neil deGrasse Tyson  Use this quote as a lead-in activity to a discussion about different kinds of observations. Students may be asked to describe how observations are important in measuring the world around us, using examples to support their ideas.  Define quantitative and qualitative observations and data. For example:  Quantitative   * uses numbers to describe amounts/quantities * data is collected by measuring things * involves using tools like rulers, meters, timers, digital devices, often using a scale * measurements given in standard metric units * data can be analysed statistically or by numerical comparisons   Qualitative   * uses words to describe data, without using numerical values * describes physical properties such as colour, feel and smell, observed using your senses * data can be described but is harder to analyse   Experimenting  Teachers engage students in a variety of scenarios involving gravity and use Predict/Observe/Explain. Ask students to then develop a hypothesis for each case. Examples might be:   * give students a variety of balls (basketball, tennis ball, netball, softball, superball, golf ball, table tennis ball) and ask them to make qualitative and quantitative observations, describing the motion when dropped from a height * construct and/or observe a swing or a pendulum and describe the motion of the mass with different lengths, masses and heights of swings * have students throw a projectile and observe and describe vertical and horizontal motion.   Students use their ideas (and further research if needed) to design and conduct an experiment to quantitatively measure acceleration due to gravity. Students should explore different methods to accurately measure motion e.g. stopwatch and ruler, videoing, data loggers  Detailing observations  Short review of cells: what is a cell? What types of cells might be found in animals and plants? What do all cells have? What are the differences between animal and plant cells? (possibly pre-test)  Before investigating cells, brainstorm different metric units of length such as km, m, cm, mm, μm and nm. Discuss the meaning of magnification.  Watch the Eames ‘Powers of Ten’ (1977) video.  Students create a ‘Powers of 10’ number line pictograph to show relative size and scale, such as given in:   * [Nanosense Lesson 2](https://nanosense.sri.com/activities/sizematters/sizeandscale/SM_Lesson2Student.pdf) https://nanosense.sri.com/activities/sizematters/sizeandscale/SM\_Lesson2Student.pdf * [Science learn – investigating size and scale](https://www.sciencelearn.org.nz/system/documents/files/000/000/419/original/Investigating_size_and_scale.docx?1475453034) https://www.sciencelearn.org.nz/system/documents/files/000/000/419/original/Investigating\_size\_and\_scale.docx?1475453034   Students include a variety of different cells in their pictographs.  Set up a number of stations with microscopes (and selected prepared slides) and images of cells (micrographs), with identified organelles, that show scales.   * examine each image and describe each cell type qualitatively and quantitatively. * discuss observations made. * identify organelles present and estimate their sizes * compare the detail observed in digital images vs light microscope observations. | * Oral presentation describing how they conducted their experiment, qualitative and quantitative measurements made and what they found. * Students complete a Venn diagram comparing and contrasting different types of cells e.g. animal vs plant. Identify the qualitative and quantitative measures used to describe the cells. |
| Students:   * analyse the quantitative data from the following information sources, including but not limited to:   + digital images and hand-drawn diagrams of cells   + geological succession obtained from rock strata   + graphs of results obtained from observations of an object falling due to gravity   + data showing the pH of acids and bases   WS INS11/12-2   * + evaluate and modify an investigation in response to new evidence   WS INS11/12-3   * + employ and evaluate safe work practices and manage risks   WS INS11/12-5   * + derive trends, patterns and relationships in data and information | Each of these sections are intended to follow on from the observations made above. Teachers may choose to cover both observations and analysis sections together, for each context area.  Detailing observations - analysing quantitative data   * Students make slides of plant cells and observe using a light microscope. For each slide, students should draw a labelled diagram and record magnification and dimensions of chosen cells. * Observe animal cells using a light microscope. For each slide, students should draw a labelled diagram and record magnification and dimensions of chosen cells. * Explore the strengths and weaknesses of seven different types of microscopes as observational tools https://www.sciencelearn.org.nz/embeds/12-which-microscope * Collect images of animal and plant cells from a variety of types of microscopy (light, SEM, confocal laser scanning) * Describe the qualitative and quantitative information that can be gained from each imaging method.   Analysing an experiment   * Use a simulation such as [free fall complete toolkit](https://www.physicsclassroom.com/Teacher-Toolkits/Free-Fall/Free-Fall-Complete-ToolKit) to analyse the motion of a ball falling: http://www4.ncsu.edu/~ckwarren/Simulations/FreeFall/   + describe the changes in distance and velocity   + calculate the acceleration (using the graph) of the ball and compare the actual acceleration due to gravity * Use ticker timers to measure the motion of a falling object   + measure distances, calculate velocities and determine acceleration * Conduct an experiment to quantitatively measure and calculate the acceleration due to gravity using a pendulum. Use the equation below to calculate   decorative   * Watch and discuss the [fall of a bowling ball and feather](https://www.youtube.com/watch?v=E43-CfukEgs) in a vacuum chamber (use Predict, Observe and Explain POE strategy) https://www.youtube.com/watch?v=E43-CfukEgs | * Visual presentation of at least three different types of cells, including name of cell, type of microscopy used, magnification and actual size (correct units). * Report(s) on experiments. * Use a cause-effect graphic organiser to summarise the effects of different variables in a chosen experiment.   Question: How does gravity affect the motion of an object?   1. gravity acts towards the centre of Earth 2. an object always falls downward 3. gravity is a force that causes acceleration 4. a falling object increases in velocity |
| Students:   * carry out a practical activity to quantitatively and qualitatively describe, for example:   + microscopic images of a variety of cells   + geological strata in rock faces and road cuttings   + an object falling due to gravity   + characteristics of acids and bases   WS INS11/12-1   * + develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data decorative | Being a chemical investigator  Provide students with samples of chemicals such as sodium carbonate, calcium chloride (anhydrous), citric acid, tartaric acid and un-iodised salt, labelled chemical A - E. Each group will also need spoons, small beakers and bromothymol blue indicator in a dropper bottle.  Students make as many qualitative observations as possible about each chemical, reactions of each with the indicator and reactions when chemicals are mixed. As an investigator, they are to collect as much information as possible about each chemical to report to class. They can make solutions using the solids provided.  Using the cooperative, problem solving approach ‘pieces of the puzzle’, each group is then given a clue to help them identify the chemicals:   * bromothymol blue will turn yellow in the presence of an acid * an acid mixed with a carbonate will produce CO2 bubbles * bromothymol blue will turn blue in the presence of a base * calcium carbonate is insoluble * bromothymol blue will turn green in a neutral solution * when water is added to calcium chloride, heat is released * sodium chloride and calcium chloride are soluble in water   Students may share their clues with other groups. The aim is for each group to determine which chemicals are acidic, basic and neutral. Can they name any chemicals used?  Finding the story in rocks  Find a rock face or road cutting near the school (or use a series of photographs) for this activity. in pairs, one student describes the layering, types of rocks, structures and colours in the profile, while the other student (who cannot see the profile) draws a labelled diagram based on the description given by his/her partner. Students compare diagrams with actual rock profiles and discuss:   * the importance of accurate communication * the use of qualitative and quantitative observations   May want to [view part of this video](https://www.youtube.com/watch?v=hG8VbdAQYwk&t=3s) looking at siltstone sedimentary layers in the Sydney Basin. https://www.youtube.com/watch?v=hG8VbdAQYwk&t=3s | * Oral report on findings. * Tabulate characteristics of acids and bases. |
| Students:   * analyse the quantitative data from the following information sources, including but not limited to:  Information and communication technology capability icon Numeracy icon decorative   + digital images and hand-drawn diagrams of cells   + geological succession obtained from rock strata   + graphs of results obtained from observations of an object falling due to gravity   + data showing the pH of acids and bases   WS INS11/12-2   * + evaluate and modify an investigation in response to new evidence decorative   WS INS11/12-3   * + employ and evaluate safe work practices and manage risks decorative decorative   WS INS11/12-5   * + derive trends, patterns and relationships in data and information | Being a chemical analyst   * What is the pH scale? * Describe how the pH scale is a quantitative measure of acidity, based on the concentration of H ions in solution. * Measure the pH of a variety of everyday substances and plot them on a pH scale. * Given pH values for common substances, describe their properties in terms of acidity/basicity and relate to the concentration of H ions. * Use the [pH scale simulation](https://phet.colorado.edu/en/simulation/ph-scale) to analyse the effect of dilution on pH https://phet.colorado.edu/en/simulation/ph-scale   Analysing data from the rocks   * Use the law of superposition to describe geological succession in given rock strata images (or actual rock faces or cuttings). * Use index fossils within rock layers to determine relative ages of fossils and the rock layers that they are in. * Research the use of radioactive dating to determine the age of rocks and minerals. Graph radioactive decay and analyse decay graphs.   Suitable resources include:   * [Radioactive dating](https://australianmuseum.net.au/radioactive-dating) https://australianmuseum.net.au/radioactive-dating * [Absolute dating](https://www.sciencelearn.org.nz/resources/1486-absolute-dating) https://www.sciencelearn.org.nz/resources/1486-absolute-dating | * Plot examples of acids, bases and neutral substances on the pH scale (with the corresponding H ion concentration) |
| Students:   * evaluate the differences between qualitative and quantitative observations and data and where these are used  Information and communication technology capability icon Numeracy icon decorative | * List examples of where qualitative observations are suited to an investigation. * List examples of where quantitative observations are suited to an investigation. * Evaluate the differences between qualitative and quantitative observations and data. Discussion may consider methods of minimising bias or subjectivity, possible over-generalising with qualitative observations and the importance of accuracy, consistency and replication. | * Complete a Venn diagram comparing and contrasting qualitative and quantitative observations. |

Reflection and evaluation:

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