 Using data loggers

Stage 6 Biology

**Note –** teachers and students are reminded that, where the planned observations have a potential impact on the welfare of animals, the provisions of the Animal Research Act must be satisfied. Before commencing any activities for Stages 4-6, please refer to the publication, **Animals in Schools; animal welfare guidelines for teachers**. Please consult the animal welfare liaison officer in your school. Before establishing a pond or aquarium and stocking it with vertebrate animals (such as fish and amphibia), refer to the above publication.

If you refer to the skills modules (8.1 and 9.1) in any of the Stage 6 science syllabuses, 12.2(a) states that, in relation to outcomes P12 and H12, [students must] “gather first-hand information by using appropriate data collection techniques, employing appropriate technologies, including data loggers and sensors”.

In this list of experiences drawn from the stage 6 Biology syllabus, suggestions are given where the use of sensors and a data logger are seen as appropriate. Sensors that are available for monitoring and measurement in biology include:

* an angular position sensor coupled to a gas syringe to measure changes in gas volume
* a carbon dioxide gas sensor for displaying the concentration of carbon dioxide gas
* coupling device to connect a data logger to an electronic balance
* dissolved oxygen sensor
* light sensor and a lamp to be used as a qualitative or model colorimeter (light absorbance is logged and colour filters or coloured light emitting diodes (LEDs) can also be used
* oxygen gas sensor
* pH electrode (sensor)
* pressure sensor
* specific ion sensors (such a s Cl-, PO43-, etc)
* temperature sensors of various ranges and construction

Syllabus

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8.2 A Local Ecosystem

* choose equipment or resources and undertake a field study of a local terrestrial or aquatic ecosystem to identify data sources and measure abiotic variables in an ecosystem using appropriate instruments and relate this data to the distribution of organisms and …. graphing changes with time in the measured abiotic data

The syllabus also requires that students “process and analyse information and present a report of the investigation of an ecosystem...” (Biology Stage 6, page 24).

This last point invites students to set up a purpose for investigating aspects of an ecosystem. Without getting too complicated, the kinds of things that you could investigate are how changes in one or two abiotic factors (such as incident light or air temperature) may directly affect other abiotic factors in a terrestrial or aquatic ecosystem (such as humidity, water temperature, oxygen content.)

A more complicated investigation could explore how changes in abiotic characteristics of an ecosystem may affect biotic activity. The issue here is to speculate about how the biotic activity would be monitored. Apart from obvious behaviour changes (in the case of animals), indirect measures of biotic activity (such as for plants) may be more appropriate.

For example, you might want to speculate that increasing the carbon dioxide concentration in a stable aquarium with lots of green water plants would lead to an increase in the dissolved oxygen content and higher water temperatures. An alternative to that might be to look at how feeding activities and later waste elimination impact on the abiotic environmental factors (such as pH, conductance, oxygen levels, dissolved carbon dioxide levels, water temperature.)

More complex relationships will be studied in the HSC module, **9.2 Maintaining a Balance**.

Examples of data relevant to the above that can be collected reliably and efficiently using appropriate sensors and a data logger include:

| Factors | Measurements |
| --- | --- |
| Wind speed | At a consistent height of say, 1.5 m |
| Air temperature | At a height of 1 m above, 0.1 m above or on the surface or in humus |
| Humidity | At a consistent height or location |
| pH | Soil, leaf litter, humus, ground water, pond water |
| Conductance | Ground water as a measure of dissolved salts |
| Water content | Of soil |
| Light | Along a transect, at surface height, in the sun, in full shade |
| Carbon dioxide concentration | In specified locations |

**Water system studies (Streamwatch)**

Specific sensors can be chosen to measure light and dissolved oxygen at depths chosen for particular reasons or consistency. Other abiotic factors of interest include conductance, dissolved solids and particular concentrations (or presence) of specific ions such as nitrate, phosphate and chloride ions.

**Pond and aquarium studies**

If using a pond or aquarium for your ecosystem, data that could be usefully collected and graphed against time include light levels, temperature above the surface, dissolved oxygen, light intensity at a depth of interest, pH, conductance, water temperature at a depth or depths of interest below the surface and humidity immediately above the water.

8.3 Patterns in nature

Transpiration study

Use available evidence to perform a first-hand investigation and gather first-hand data to identify and describe factors that affect the rate of transpiration

* demonstrate the need for chlorophyll and light in photosynthesis (p. 27)
* demonstrate the relationship between surface area and the rate of reaction (p. 27)
* identify and describe factors that affect the rate of transpiration (p. 28)

Use either outdoor plant leaves or a potted plant with pot and lower stem sealed in plastic bag resting on an electronic balance connected to a data logger. Data related to humidity, CO2 concentration, temperature inside plastic bag, temperature outside plastic bag, light intensity can be collected and evaluated

Data logger and pressure sensor as a photometer

* perform a first-hand investigation of the movement of materials in xylem or phloem (p. 28)

The pressure sensor can be attached to a plant stem to measure transpiration pressure or osmotic pressure.

9.2 Maintaining a balance

Demonstrate the effect of:

* increased temperature
* change in pH
* change in substrate concentrations on the activity of named enzyme(s) (p. 40)

Examples of activities that can be set up and monitored using appropriate sensors

Use rennin and milk or peroxidase and liver; log over time.

Use digestion of egg white (albumen) by pepsin. Make up home-made colorimeter, using light source and light sensor on either side of the containing chamber (vessel), and measure the light transmitted through the mixture. Alternatively, use a commercially made colorimeter or colorimeter sensor attached to a data logger. Plus try measuring temperature.

Measure amylase activity using light transmitted through a mixture of amylase, starch and iodine solution.

Lipase and butter fat in milk, monitor pH over time; needs sodium carbonate solution to bring the pH to about 9 to start; use a few drops of detergent as an emulsifier and compare lipase activity with and without emulsifier.

* ...demonstrate the effect of dissolved carbon dioxide on the pH of water (p. 45)

See notes above relating to pond and aquarium studies and other activities in 8.2.

9.6 Option – Biotechnology

* “...perform a first-hand investigation...to demonstrate the use of fermentation processes in bread or alcohol production” (p. 55).

Data loggers can monitor the changes in the abiotic environment as a result of the activity of the biotic component. In fermentation, changes in temperature, dissolved oxygen, dissolved carbon dioxide, pH and alcohol concentrations can be monitored using appropriate probes.

9.9 Option – Biochemistry

* perform a first-hand investigation to...determine the effect of light intensity or temperature on gas production in a suitable pond weed (p. 70).

See earlier notes on pond and aquarium studies.

You may want to demonstrate how a sensor can be used to detect one or more forms of radiation (alpha, beta or gamma radiation) from radioactive sources (isotopes of carbon, oxygen etc.) when talking about the biochemical reactions and processes on p. 71 of the syllabus.