Datalogging

Students are watching paraffin wax melt as heat energy is added. They can see a "real time" graph on a computer screen of the temperature changes that are occurring as the wax melts. While watching the changing shape of the graph and the melting wax, they are listening to an explanation by the teacher of the energy changes occurring during this change of phase. The students are then asked to investigate whether similar energy changes take place when the melted wax solidifies.

What is Datalogging?

Datalogging is the process whereby physical data e.g., temperature, humidity, motion, pressure or light is collected using electronic sensors, which are usually built in to a device known as a datalogger. The data is then downloaded from the datalogger and stored to a computer or other hardware such as a laptop, personal digital assistant (PDA) or graphics calculator. Specialised software programs enable this data to be displayed on a computer (or other hardware) in the form of charts, graphs and tables. It is also possible to open these collected data files in a spreadsheet program as tab delimited text or the more common CSV (comma separated values) figures.

Possible Educational Uses

The process of measurement and data gathering is a common feature of practical work in a school science laboratory or as part of a maths or geography lesson. Datalogging automates this process so that tedious repetitive tasks are removed and there is a stronger focus on the procedural aspects of practical work. More specifically, datalogging may be used to:

- Record data accurately and instantaneously, i.e., in "real time", in the classroom, science laboratory or on field trips
- Store data in the memory of the datalogger with a view to connecting it at a later time to a computer (or other hardware) for presentation, analysis and manipulation
- Produce a "real time" graphical representation of an investigation or experiment on a computer monitor
- Pause an experiment in order to add text to a graph to mark actual events within the experiment
- Focus on the development of students' scientific enquiry and higher order thinking skills such as data analysis, interpretation of graphs, result prediction and reflecting on the control of variables. Students can concentrate on interpreting the significance of the data collected rather than having to concern themselves about the mechanics and equipment used to collect it.
- Enable students to repeat experiments several times due to the speed at which data is collected
- Collect data at different intervals, for a specified time or at a time of a particular event, such as a threshold of sound, temperature or light
- Promote collaborative learning
- Enable students with special educational needs to easily carry out and complete investigations
- Allows students to conduct experiments over prolonged periods of time, e.g. overnight to log temperature and light conditions in a classroom or lab
- Allow students to display results in a variety of formats such as graphs, tables or meter readings
- Cuts down on the number of errors made when manually transcribing figures/data from recorded experiments

Typical examples of datalogging activities are presented in the following table:

	Science Laboratory	Classroom	Field Trip
Experiments	pH investigations Heat changes in chemical reactions Investigating light& sound Measurements involving pressure Co2 & O2 production by organisms	Mathematical manipulation of scientific data Measuring the loss of heat through sweat production Investigation of heart rate	Measuring temperature of exposed and shaded wall Ecology studies Water profiles Light intensity Acid rain

Technical Considerations

In general, a datalogging unit is made-up of a number of interdependent components, i.e., sensors, a datalogger, software and additional hardware such as a desktop, laptop, graphic calculator or personal digital assistant.

Sensors

A sensor is a device that senses surrounding data which is then recorded by a datalogger. Generally, four or more sensors are capable of being connected to a datalogger, depending on the model. There are over 40 different sensors available, including light, temperature, pressure, conductivity, motion, humidity, oxygen, Carbon dioxide, pH and voltage, altitude, dew point, wind speed, and wind chill.

Datalogger

A datalogger is a basic box capable of picking up and storing signals from sensors. For ease of use they generally have a minimum number of displays and controls and their portability enables remote datalogging, i.e., logging data away from the computer. Dataloggers are either fitted with an internal battery that is rechargeable or use regular alkaline batteries. Some may also have external power supplies. Most data loggers store data in non-volatile memory, which means the data will not be lost if the power supply fails. It is important to note that low battery charge may cause some dataloggers to behave erratically. A cable or docking station is normally provided to facilitate a connection to a computer (or other hardware). Dataloggers can also make use of Bluetooth or Infra red communication to transfer data.

Software

Typically, datalogging units include software, which allow data to be transferred from the datalogger to a computer (or other hardware) in order to be analysed, presented graphically or manipulated. Software also allows the datalogger to be programmed for remote use. Issues such as ease of use and installation, quality of graph production and analysis, data transferral and manual input of data depend on the quality of the software.

Additional Hardware

Desktops, laptops and hand held systems such as graphing calculators and personal digital assistants are requisites for any datalogging unit. Some technical considerations to note are as follows.

- Laptops and desktops are more appropriate for whole class demonstration.
- The majority of operating systems support datalogging hardware and software but it is advisable to check this with the datalogging manufacturer

- Data may be stored using traditional storage methods, i.e., hard drive, floppy disk, USB pen drives
- Extension cables may be required in order to transfer data from hand held systems to other hardware
- Personal digital assistants that offer colour display and sound are a more expensive option but are less robust than graphic calculators

Refer to Advice Sheet 4 on Laptops, Advice Sheet 5 on PDAs and Advice Sheet 2 and 3 for PC and Apple for respective technical considerations.

Purchasing Considerations

Prices tend to vary from Euro 180- 800 including software. Lesson plans, power adaptors, serial leads accompany some products. Other considerations include:

- Some of the Biology and Chemistry sensors (e.g., Dissolved Oxygen) can be expensive to purchase
- As sensors are not generally easily exchanged between systems it is advisable to check with the supplier to see which ones are supplied with the datalogger
- Features such as robustness and full colour capability will increase the price of personal digital assistants and graphing calculators
- Graphing calculators are inexpensive for initial purchase and easy to replace but have limited memory capability at the lower end price range

Refer to Advice Sheet 4 on Laptops, Advice Sheet 5 on PDAs and Advice Sheet 2 and 3 for PC and Apple for respective purchasing considerations.

Relevant Web Sites

SIP Project – Datalogging
www.sip.ie/sip052
A Schools Integration Project (SIP) website that highlights the role of graphic calculators in datalogging in the context of teaching science in Ireland.

Implementation and equipment
www.rogerfrost.com/equipment.htm
Provides general information on datalogging, purchasing and technical considerations, datalogging experiments and reviews datalogging equipment.

Primary School Experiments
www.hitchams.suffolk.sch.uk/datalogging/examples.htm
A website belonging to U.K primary school that features examples of datalogging experiments appropriate for various age groups.

Note: While the advice sheets aim to act as a guide, the inclusion of any products and company names does not imply approval by the NCTE, nor does the exclusion imply the reverse. The NCTE does not accept responsibility for any opinions, advice or recommendations on external web sites linked to the NCTE site.

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