

Teaching Strategies and Resources

Examples

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The new stage 6 science syllabuses draw on constructivism, a pedagogy based on educational research relating to teaching and learning. Teachers will need to employ appropriate strategies and use new resources to deliver the material effectively. UniServe Science has identified a number of useful alternate teaching strategies and associated resources. The following examples illustrate the application of some of these strategies to selected topics within the syllabuses.

The UniServe Science web site contains links (<http://science.uniserve.edu.au/school/tutes/tsr/>) to identified resources for use with each of the following examples.

Senior Science

Topic: *Lifestyle Chemistry*

Strategy: Visual organisers such as Concept maps/Vee diagrams

Meaningful learning results when a person consciously and explicitly ties new knowledge to relevant concepts they already possess. The concept map is a device for representing the conceptual structure of a topic in a two dimensional form which is analogous to a road map. Concept maps are diagrammatic representations that show meaningful relationships between concepts. In the teaching and learning of science, concepts do not exist in isolation. Each concept depends on its relationships to many others for meaning. A concept map depicts hierarchy and relationships among concepts. The concept map construction process requires students to think in multiple directions and to switch back and forth between different levels of abstraction.

A Vee diagram guides students through investigations that they choose themselves. This less-structured investigative arrangement allows students to actively learn the principles of investigation. The Vee diagram helps students to better organise their thinking, investigate more efficiently, and create guidelines for learning.

Application: Concept maps provide an excellent vehicle for stimulating the recall of previous knowledge and applying that knowledge when preparing an investigation, assimilating new information or applying the knowledge to specific situations. In this topic, the knowledge of concepts and terminology associated with solubility is important in preparing an investigation of types of tablets and capsules. It is also important in understanding the use of solvents in cosmetics and external medications. In a similar way, a Vee diagram might be used to plan an investigation to compare the solubility of various tablets and capsules.

Topic: *Information Systems*

Strategy: Posters

The poster has become one of the most important types of scientific communication at societal meetings and scientific conferences. The power of the poster is that the communicants can directly discuss their data and interpretations in a small group atmosphere. The feedback generated during these discussions generally proves to be more useful than the feedback in question and answer sessions following the more traditional slide presentations.

Generally, scientific posters are the outcome of group efforts. In keeping with the team approach so common to the modern sciences, posters provide a cooperative learning experience in which a group

of students research a topic, design posters and orally defend their presentations before students and teachers.

Application: The whole class brainstorm to produce a timeline of communication systems introduced to society, as identified in the syllabus. The class is then split into groups with each group choosing a communication system to research. The research and subsequent poster could analyse: the basic pattern of information transfer; applications of the system; its impact on society; and the use of electrical impulses for transmission (if applicable). After completing the literature search groups report (to the teacher) on the search and selection of the most important resources. In the next stage students are required to produce an outline of the material to be covered in the poster. This is submitted for appropriate comments regarding the conceptual framework of the project. Prior to the presentation of the poster, the student groups must present a draft of the poster layout. During this advisory session, the teacher emphasizes that the material must be presented in a clear, logical and concise manner. It is not the role of the teacher to direct the layout. However, they may suggest or question the omission of some data or analyses. Using the timeline for ordering, groups present their posters to the class. Each group must defend their poster. The teacher and students ask questions which may be drawn from any material on the poster and other material pertaining to an understanding of the data and concluding statements.

Topic: *Preservatives and Additives*

Strategy: WebQuest

A WebQuest is an inquiry-oriented activity in which most or all of the information used by learners is drawn from the Web. WebQuests are designed for cooperative learning and peer assessment. They focus on using information rather than looking for it, and support learners' thinking at the levels of analysis, synthesis and evaluation. There is questionable educational benefit in having learners surfing the net without a clear task in mind, particularly given the limited time that most students have to access the net. To achieve efficiency and clarity of purpose, WebQuests should contain at least the following parts:

- an introduction that sets the stage and provides some background information;
- a task where the outcome is achievable and interesting;
- a set of information sources needed to complete the task;
- a description of the process the learners should go through in accomplishing the task;
- some guidance on how to organize the information acquired; and
- a conclusion that brings closure to the quest, reminds the learners about what they've learned, and perhaps encourages them to extend the experience into other domains.

Application: The most controversial of the methods of food preservation as identified in the syllabus is food irradiation. A number of WebQuests already exist on this topic. Students are supplied with links to web pages in order to prepare individual or group responses to questions such as "Should I support irradiation as a way to combat food borne illness, why or why not?" and "What role should irradiation play in the food industry?". In this topic, students are also expected to "gather information from the Australian Standards Food Code" and "discuss the use of codes by the National Food Authority on labels as alternatives to the names of preservatives and additives". This content could form the basis of a WebQuest that guided the students through the identification of particular chemicals that are used as preservatives and additives, their advantages and disadvantages and finally to decide what they feel is appropriate for labelling purposes.

Topic: *Medical Technology – Bionics*

Strategy: Mini-conference

A conference is a meeting where participants give oral presentations on subjects revolving around a common theme. Each student (or group of students) selects a topic from the given list, researches

information on the topic, and prepares and delivers a comprehensive, concise, and complete oral presentation to the class. Each presentation should be at least three minutes but not more than five minutes in length. A time for questioning should follow each presentation. All the papers presented should be collated into proceedings given to each student. The audience for the conference could include students from another class.

Mini-conferences create situations where students become active learners and improve their skills in oral and written communication, writing and presenting different text types for different audiences and working in teams. It also assists them in developing their lifelong learning skills.

Application: Divide the class into four groups. The groups choose, or are allocated, the topics: the heart; the skeletal system; the respiratory system; or medical techniques. Each group is broken into smaller groups to address specific aspects of their topic. For example, the group covering the heart could split into three sub-groups and cover: structure and function; heart disease; and the use of biomaterials and biomedical devices. Each sub-group researches and prepares a presentation and paper for publication. The four groups present, one per double period, over two or three weeks. All presentations allow for question time. The mini-conference has a programme and all papers are collected and published in proceedings. All students are issued with a copy of the proceedings.

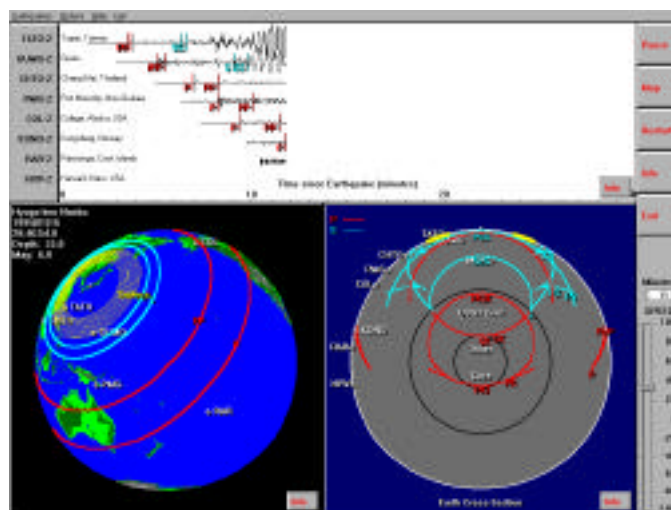
Topic: *Disasters*

Strategy: software and on-line activities

Good software and on-line activities encourage students to engage with the learning materials in a stimulating and realistic context and offer students opportunities to experiment and explore situations that are not practical in the classroom.

Application: There are a number of interactive resources available either on-line or that can be downloaded from the Web to enrich this topic. *Virtual Earthquake* is an interactive web-based program designed to introduce the students to the concepts of how an earthquake epicentre is located and how the richter magnitude of an earthquake is determined.

Seismic Waves: A program for the visualization of wave propagation is a Windows program that illustrates how waves propagate from an earthquake hypocentre to seismic stations throughout the earth. One sees waves propagating out from the epicentre on a three-dimensional view of the earth at the same time as one sees waves propagating through a cross-sectional view of the earth.



Screen image from *Seismic Waves*

Seismic/Eruption: A program for the visualization of seismicity and volcanic activity in space and time. The program, which runs under *Windows*, has an extensive database of events. A number of pre-defined maps are included which illustrate the seismicity in various parts of the earth.

Community risk in Cairns: a multi-hazard risk assessment is a CD-ROM available from Australian Geological Survey Organisation. It is based on a study that has assessed the risk to Cairns from earthquakes, landslides, flooding, and tropical cyclones. It describes the hazard history of Cairns, and the risk to the community from individual geohazards.

Topic: *Disasters*

Strategy: Case studies

The use of case studies holds great promise as a pedagogical technique for teaching science because it humanizes science and well illustrates scientific methodology and values. It develops students' skills in group learning, speaking, and critical thinking, and since many of the best cases are based on contemporary, and often contentious, science problems that students encounter in the news (such as human cloning), the use of cases in the classroom makes science relevant. Students exposed to the case method have been extraordinarily excited and actively involved in their learning.

Application: Bushfires are a constant threat to much of Australia and in recent years have provided a number of fires that could be used as case studies: the Sydney fires of 1994, the Ash Wednesday fires in Victoria and South Australia and the 1967 Tasmanian fires. The fires could be compared on type and condition of vegetation in the area, weather conditions at the time, slope of land and damage in terms of loss of life and property. Similar case studies could be undertaken on significant cyclones. All of these case studies would feed into the database of natural disasters that is created as part of this topic.

Topic: *Disasters*

Strategy: Debates

Debates can be on any topic that is appropriate for critical scientific inquiry. They may involve surveying evidence on the Internet to answer a complex scientific question or support a theory. The project culminates in a classroom debate, in which students present their arguments and supporting evidence and field questions from the rest of the class. Debates: help learners distinguish ideas in their repertoire; help learners expand their repertoire of ideas and recognize biased or invalid arguments such as they might find on the Internet; and help learners draw on scientific information to solve complex problems.

Application: There has been considerable coverage in the press recently related to insurance companies failing to "pay out" on claims that they identify as the result of human activity e.g. the August 1998 floods in Wollongong (or was it just excessive rain and poor run-off). Students could undertake a debate to discuss "insurance compensation and 'acts of God'" in order to gain an understanding of the "definitions and terminology used in insurance contracts".

Physics

Topic: *From Ideas to Implementation*

Strategy: Debates

Application: Divide the class into three groups. Each group is given a topic for debate from the following:

- science research is removed from social and political forces;

- superconductivity is a new state; or
- inventions of television, transistors and superconductors were equally significant.

Chemistry

Topic: *Chemical Monitoring and Management*

Strategy: WebQuest

Application: In this topic, students are required to gather information about a variety of chemical occupations and to select one occupation for more detailed study. This could be the basis of a valuable WebQuest where students are directed to various web sites (prepared by universities and professional societies) that outline the various career paths for their potential graduates and members respectively. A more general, already existing, WebQuest (Careers in Science) would form an excellent basis for this WebQuest. An alternative WebQuest could be prepared to address the requirement “to describe and explain evidence for the need to monitor levels” of one of a number of identified ions, one of which is lead. The WebQuest could cover links to uses of lead and lead poisoning. This could be extended to the other ions identified with students being asked to prioritise the need for monitoring the particular ions in given areas e.g. urban areas and lead, rural areas and waterways and phosphates.

Earth and Environmental Science

Topic: *Environments Through Time*

Strategy: Mini-conference

Application: The conference focus is on mass extinction. Divide the class into groups. The groups choose, or are allocated, the topics: Late Cambrian; Late Ordovician; Late Devonian; End Permian; Late Triassic; End Cretaceous; and extinction of the Australian megafauna. Each group researches and prepares a presentation and paper for publication. Material could include: abundance and diversity of life before the event; abundance and diversity of life after the event; significant locations; and possible cause – observed geological features. All presentations allow for question time. The mini-conference has a programme and all papers are collected and published in proceedings. The audience could include biology students. All students are issued with a copy of the proceedings.

Biology

Topic: *Blueprint of Life*

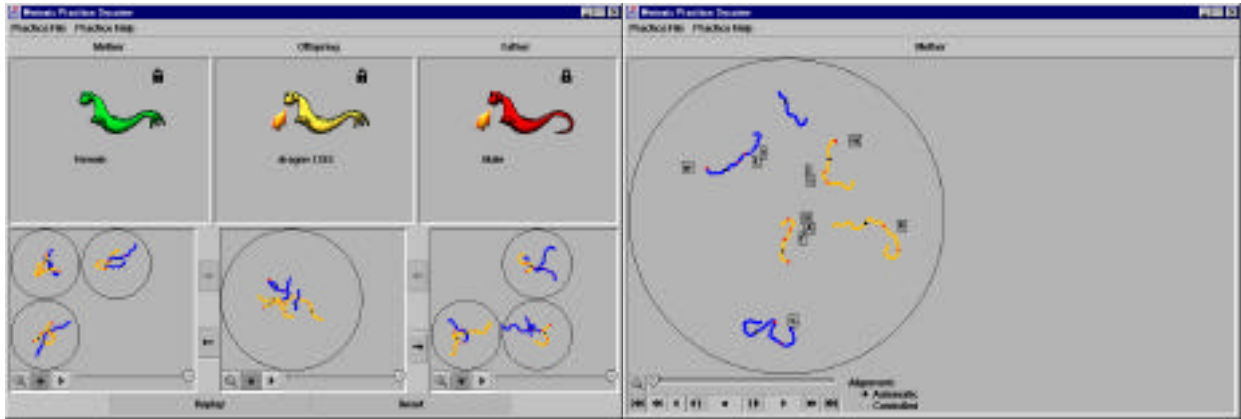
Strategy: software and on-line activities

Application: This topic is particularly well catered for with interactive resources that can be used on-line or downloaded and installed on a computer.

GenScope is an interactive investigation that covers much of this topic by exploring the genetics of a dragon species. The student can observe changes in colour, horns, legs and the ability to breathe fire by manipulating the combinations of genes. Some of the characteristics are simple dominant/recessive, others display incomplete dominance, sex-linkage and one allele is fatal. The program simulates the breeding of successive generations to explore the inheritance of characteristics. Mitosis and meiosis, crossing-over, DNA, mutations are also covered. The program is accompanied by worksheets and teacher’s hints. It is free to download but is available only for

Macintosh. Additional files can be downloaded which explore the selected genetic attributes of humans, dogs and horses.

The makers of *GenScope* have produced a newer package called *BioLogica* which is available for both Windows and Macintosh. *BioLogica* is more structured in its presentation of material but covers similar content. It can also be downloaded for free.



Screens from *BioLogica*. The left screen is generated by a short animation to show the meiosis and the formation of sex cells, followed by the fertilisation and resulting offspring. The right screen allows the identification of the genes on each chromosome and for controlled alignment and for “designer” dragons.

Available from the *BioLogica* site are two on-line activities: *Dragon Genetics* introduces genotype to phenotype relationships and *Mendel’s Peas* demonstrates principles of Meiosis and Pedigree, and then presents a challenging (but fun) problem requiring prior knowledge of genetics.

Topic: *The Search for Better Health*

Strategy: Case studies

Application: This topic lends itself to many case studies. Students are expected to study one infectious disease in detail to describe the cause, transmission, host response, major symptoms, treatment, prevention and control. While this might be covered by the whole class studying the same infectious disease, e.g. malaria would be the most likely choice, there are sufficient resources on the Web that groups of students may study different diseases that interest them and are more relevant to Australian conditions, e.g. Newcastle disease, Ross River Fever or Legionnaire’s Disease.

Epidemiology is fresh content in the new syllabus. Students might be presented with a number of case studies of non-infectious diseases. Lead poisoning, Minamata disease, skin cancer, asbestosis, heart condition and smoking are just a few examples.