Teaching Strategies and Resources for Physics Teaching

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The Stage 6 science syllabuses draw on constructivism, a pedagogy based on educational research relating to teaching and learning. Teachers need to employ appropriate strategies and use a variety of 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 Physics.

The UniServe Science web page Alternative Strategies for Science Teaching and Assessment (http://science.uniserve.edu.au/school/support/strategy.html) contains links to identified resources for use with each of the following strategies.

**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.

Applets are small programs, often written in Java, which usually runs in a web browser, such as Internet Explorer or Mozilla. Physlets are Physics Applets while Flashlets are similar but developed using programs such as Easy Flash and Macromedia Flash.

There are many well developed and reputable sites offering a great variety of applets relevant to the Physics syllabus. UniServe Science has developed a web page to facilitate access to these sites. It can be found at http://science.uniserve.edu.au/school/curric/stage6/phys/physapplets.html.

A recent web sites offering multimedia modules of particular interest is that developed by The University of New South Wales for the 2005 International Year of Physics commemorating Einstein’s Miraculous Year. **Einstein Light** contains with modules on Galileo (mechanics and relativity), Maxwell (electricity and magnetism), Einstein (relativity and constant c), Dilation (follows from relativity) and E=mc² (relativity and mechanics) and can be found at http://www.phys.unsw.edu.au/einsteinline/

**Strategy: Visual organisers such as Concept Maps**

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.

An excellent summary of visual organisers from the Center Applied Special Technology can be found at http://www.cast.org/publications/ncac/ncac_go.html
Examples of Visual Organisers in Physics include
Hyperphysics (http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html) from Georgia State University at uses hierarchical concept maps to cover much of the Physics syllabus;
Reactors Physics Concept Map (http://canteach.candu.org/reactorphysics_map.html)
Newton’s Laws Concept Map (http://www.batesville.k12.in.us/physics/PhyNet/Mechanics/Concept_Map.htm)

**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.

One possibility for using Posters in the Physics syllabus would be within *The World Communicates* where students are required to cover energy transformations in mobile telephones, fax/modem and radio and television. In small groups, students should prepare a poster that illustrates the energy transformations that occur in one of the stated technologies. During this advisory session, the teacher emphasises 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 a 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.

An alternate topic that would be well suited to poster presentations is that of presenting information about the application of reflection and refraction in today’s communication technologies. This might include illustrations of the path of reflected rays for plane surfaces, concave and convex surfaces and reflection of radio waves by the ionosphere and their application as well as refraction and total internal refraction.

**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**: UniServe Science has developed two WebQuests for use within *From Ideas to Implementation* module within the Stage 6 Physics syllabus. These are **Superconductivity** and **Semiconductors and Modern Living**. The can be found at http://science.uniserve.edu.au/school/quests/

**Strategy: Virtual Field Trips**

Educational software simulations provide a powerful tool for educators, offering an opportunity for learners to experience situations that are otherwise unavailable because they are too dangerous, too expensive, too long in duration, or removed from the learner in time and/or space. In a similar way, the Web offers an even greater audience the opportunity to be involved in a range of scientific experiences particularly in the areas of geology and biology. Not so easy in Physics. What about a virtual field trip to a Black Hole!

Two examples are

• Black Holes: Gravity’s Relentless Pull  
  [http://hubblesite.org/discoveries/black_holes/home.html](http://hubblesite.org/discoveries/black_holes/home.html)
• Virtual Trips to Black Holes and Neutron Stars  

**Strategy: Case studies**

The use of case studies holds great promise as a pedagogical technique for teaching science because it humanises 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.

**An excellent source for case Studies in Science** is the National Center for Case Study Teaching in Science at University of Buffalo: [http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm](http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm)

These case studies are very well prepared with scenarios as well as Teaching Notes. Some case studies in physics and engineering available from this site include:

• **The Day They Turned the Falls On: The Invention of the Universal Electrical Power System** – detailing the history of the use of a natural resource, Niagara Falls, to generate electricity;
• **The Zoom Lens: A Case Study in Geometrical Optics** – students are asked to take the part of an engineering design team and design a zoom lens that meets certain design specifications;
• **Lost in Space: A Case Study in Engineering Problem-Solving** – the failure and loss of the Mars Climate Orbiter is examined in this case study, which explores the political, ethical, and economic issues as well as the scientific and technical aspects of the mishap.

From the Problem based learning Clearinghouse at the University of Delaware comes:

• **A Bad Day for Sandy Dayton** – exploring the relationship between speed and stopping distance, reaction time and stopping distance, and design and safety features of seatbelts and airbags ([http://www.udel.edu/pblc/samples/badday/](http://www.udel.edu/pblc/samples/badday/)).
**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.

Suitable topics from *From Ideas to Implementation* might be:

- science research is removed from social and political forces;
- inventions of television, transistors and superconductors were equally significant.