MODULE CONTENT

Module Title: **CUTTING EDGE SCIENCE**

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Module Description:

This module will help participants to identify the difficulties encountered when introducing Year 7–12 students to a cutting edge science topic.

Participants will examine ways of locating current information from a variety of sources, including the Internet, professional journals and magazines. They will practice rewriting complex technical material to improve its intelligibility and better suit their students' existing levels of understanding. The module will also focus attention on the importance of providing students with activities that introduce new content while avoiding cognitive overload.

The module introduces participants to a process, which can be used to explore the intended ideas, as well as other examples of cutting edge science. The focus on imaging technology is used as an example, which will provide links with Module 3: Learning Technologies in School Science. It is not intended to be the only content choice for facilitators to use with this module.

Summary of Activities:

	Title	*Min*
1.0	"Taking Charge"- A current topic.	15
2.0	The difficulties of teaching a cutting edge science.	10
3.0	Identifying cutting edge science topics.	10
4.0	Why choose imaging technology?	5
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9.0	Some alternative activities.	15
10.0	Researching your own cutting edge science topic.	5

Module Outcomes:

- Identify a range of cutting edge technologies suitable for inclusion in CSF levels 5 to 7 and strategies for researching them.
- Identify the main difficulties encountered when designing and teaching a unit on a CES to secondary students.
- Develop strategies to increase student engagement in the delivery of a CES unit and avoid student cognitive overload.
- Provide practice at assessing the intelligibility of highly technical content and rewriting it for student use.

Resources and Materials:

- White board/black board chalk or pens.
- Internet access with printer (1-2 persons per work station).
- Photocopy facility for participants to reproduce printed copy.
- Corrugated cardboard; yellow, orange and grey card (if doing activity in 9.1)
- Overhead projector.
- Video camera or "QuickCam VC" and Infrared remote control unit.
- Attachments 1.3, 5.2, 9.1 and 9.4.
- www sites.

Activity 1.0: "Taking Charge" – A current topic

Purpose: To provide an example of a current cutting edge science topic and the possible implications it may have on changing current technology in the area.

Teaching Procedures: "Brain storming" activity and use of Attachment 1.3 "*Taking Charge" – A current issue* and discuss.

Time allocation: 15 minutes

What to do

FACILITATOR	PARTICIPANT
1.1 Canvas participants' ideas about their current knowledge of battery technology. Develop a list of familiar battery types on the white board. These could include; • Dry cell carbon • Nickel Cadmium ® • Lithium • Alkaline • Lead Acid ® • Nickel-Metal Hydride ® • Mercury Oxide ® = rechargeable	1.1 Respond and contribute to discussion points.
1.2 Ask participants to identify which ones they know to be rechargeable? Discuss why laptop computers and mobile phones are increasingly switching to the use of Nickel-Metal Hydride batteries. ❖ Identify the problem of "A memory effect" when recharging a Nickel Cadmium battery when it is not fully discharged. ❖ Nickel-Metal Hydride batteries can be "topped up" at any time without effect on battery life	1.2 Draw upon current experiences of mobile phones, laptop computers, car batteries etc.

1.3 Handout Attachment 1.3 *"Taking Charge" – A current topic,* to participants and discuss the development, advantages and possible implications of the *Vanadium Redox Battery* storage system.	1.3 Read and discuss the articles presented in Attachment 1.3 "*Taking Charge" – A current topic.*
1.4 Raise the question "When discussing energy storage systems should we ignore this Australian cutting edge breakthrough?"	1.4 Discuss the implications of the VRB storage system for electric vehicle transport and emergency power systems.

Discuss/Consider:

- Intelligibility of content
- "Unjumbling" as an alternative teaching procedure to traditional note taking.

Tips and Tricks:

- The focus on battery technology is used only as an example of a cutting edge science technology currently in the media. It is not intended that the facilitator does more than introduce the topic. Do not attempt to "teach" about battery technology in great depth.
- Many participants will have agreed to lease the DEET laptop computers (or will know of someone who did), and will be familiar with the "Battery conditioning instructions" provided at the laptop workshops for the Nickel-Metal Hydride battery. Many more will be familiar with the recharging instructions for their mobile phones. Be sure to be seen to draw upon these common experiences when developing the activity.
- There may be some important "gender issues" related to research and development in science which participants may wish to discuss if time permits or note for future reading. (Reference: Hooten, Amanda (1999), "Eurek*her!*".The Age, Saturday, March 6th, p.41.)

Activity 2.0: The difficulties of teaching a cutting edge science

Purpose: To identify the difficulties that may be encountered when designing and teaching a cutting edge science unit.

Teaching Procedures: Think – Pair – Share

Time allocation: 10 minutes

What to do

FACILITATOR	PARTICIPANT
2.1 Ask the question, "What difficulties might you encounter when trying to teach a cutting edge science?" Give individuals a minute or two to consider the question.	2.1 Participants to note the difficulties as individuals.
2.2 Encourage participants to group into pairs and further discuss the question for a minute or so.	2.2 Participant's pair up and discuss each others' suggested difficulties.
2.3 Ask each pair to provide one example of a difficulty they've encountered. Repeat with each pair until ideas are exhausted.	2.3 Participants then report back to the group to formulate a master list.
2.4 Record difficulties on white board. Alternatively, an overhead transparency could be used to provide some prompts and record suggestions.	2.4 Participant's record problems identified.

Discuss/Consider:

- Ease of access to current information.
- Prior subject knowledge and specialist backgrounds or interests.
- Intelligibility of content and rewriting materials to improve understanding.
- Conceptual understanding and links to "Big ideas" in science.
- The difficulties of student engagement and devising tasks for activity driven content delivery.

Tips and Tricks:

- Consider asking participants the question "Who has ever tried to introduce their class to a cutting edge science issue?" This may help to target individuals with experience to focus discussion around.

- Try to keep the initial discussion fairly general in nature, without focusing on any specific examples or difficulties associated with unique cutting edge science topics.

- Keep this activity short as it is intended only to 'quickly' identify the main difficulties. It is not intended to be an exhaustive list.

- Try shifting the focus of the discussion near the end of this activity towards identifying suitable cutting edge science topics ready to lead into the next activity.

Activity 3.0: Identifying cutting edge science topics

Purpose: To encourage participants to identify suitable topics for study as a cutting edge science topic.

Teaching Procedures: Ordering notes from a jumbled summary.

Time allocation: 10 minutes

What to do

FACILITATOR	PARTICIPANT
3.1 Ask participants to suggest topics suitable for study as a cutting edge science at CSF levels i.e.5-6+ or VCE.	3.1 Offer suggestions of suitable cutting edge science topics
3.2 Write these topics down on the white board in random positions. Do not attempt to order or sequence them in any way.	
3.3 After establishing about a dozen or so topics on the board, ask participants to consider what criteria could be used to categorize or group them?	3.2 Suggest suitable criteria for categorising the topics suggested on the white board
3.4 List criteria. Select a few key criteria and request assistance from the participants to categorise the suggested topics.	3.3 Assist in categorising the suggestions.

Discuss/Consider:

- Revisit the difficulties identified in Activity 2.0 of teaching a cutting edge science topic. This may help participants better evaluate those that are simply beyond the secondary curriculum.

Tips and Tricks:

- Try to keep the discussion fairly general without focusing on any specific examples of researching difficulties associated with individual cutting edge science topics.

- Examples of suitable criteria for categorising topics:
  CSF II levels;
  CSF II strands, substrands, topics;
  Intelligibility;
  Required background knowledge;
  Similar "big ideas".

- Some examples of cutting edge science topics promoted by local Australian public companies are listed below. Strategies for researching them will be explored in Activities 5&6..

* Vanadium Redox Batteries, *University of NSW & Pinnacle VRB*
* Release of Flu vaccination, Relenza, *BIOTA Holdings, VIC*
* Genetic transformation of plants (Blue Carnation), *Florigene, VIC*
* Green Solar Cells (Prof. M. Green), *University of NSW*
* Micrografting of plants, *National Herbarium ACT*
* Robotic Micropropagation of plants, *ForBio Limited QLD.*
* Multiple transplantation using single donor organs, *Royal Melb. Hospital VIC*
* Bionic ear development, *Royal Melb. Hospital VIC*
* Artificial Organ and Tissue growth, *Royal Melb. Hospital VIC*

- Keep a note of participant suggestions on a section of the white board. This will be helpful for Activity 10.0 where participants will be asked to choose a topic for their own research.

Activity 4.0: Why choose imaging technology?

Purpose: To justify *digital imaging technology* as a suitable topic for the development of researching skills in this module.

Teaching Procedures: Group discussion. (Facilitator may choose to research an alternative topic to the one above. However, be aware of the need to choose a topic that still presents a similar range of content difficulties and maintains links with other modules.)

Time allocation: 5 minutes

What to do

FACILITATOR	PARTICIPANT
4.1 Imaging technology provides a topic with all the problems of most cutting edge science topics. Pose the question " Why choose this topic to explore in this module?"	4.1 Respond to question.
4.2 Participant suggestions may be noted on the board.	4.2 Contribute to group discussion.

Discuss/Consider:

- The use of digital and video cameras is increasing and most users have little understanding of the process by which the image is formed or processed.
- The topic highlights the problem of rapid technological development and the difficulties of sourcing current product information.
- Digital imaging is based on quantum physics, which is technically demanding to explain. Cognitive overload may be a problem.
- How the topic provides links with module 3*: Learning Technologies in School Science* to enhance understanding of the digital imaging technology used.
- The topic provides insights into the advantages and disadvantages of this technology.

Tips and Tricks:

- Ask the participants to suggest reasons for the topic of choice. Do not attempt to avoid silence – thinking time – by providing suggestions too quickly. Encourage the participants to play a major role in providing suggestions and increase your wait-time.

- Ensure that this topics' related links with other modules is made clear.

- If choosing an alternative topic, ensure that it provides similar difficulties of content intelligibility and maintains links to other modules. The topic needs to be complex and provide a good range of Internet sites to explore in Activity 5.0

Activity 5.0: Researching using the Internet

Purpose: To provide participants with experience in researching a cutting edge science topic using the internet and with a comparison between "browsing" and "focused" research.

Teaching Procedures: Internet research activity

Time allocation: 30 minutes

What to do

FACILITATOR	PARTICIPANT
5.1 Begin by setting the participants the task of searching the Internet for information on *Digital Imaging Technology.* (Allow 3-4 site visits only and pace according to speed of local Internet access).	5.1 Initial unguided browsing on the Internet for related information on *Digital Imaging Technology.*
5.2 Discuss the importance of formulating key research questions as a focus for inquiry. Refer to Attachment 5.2 (or use as OHT). Use the three key questions provided to focus participant's research. Stress the importance of a correct key word search. *Q 1. What materials are used to manufacture a Charge Coupled Device? (CCD).* Use a labelled diagram as part of your answer. *Q 2. How does light interact with the CCD to store information?* *Q 3. How is the information stored on the CCD processed to interpret an image?*	5.2 Focused research on the Internet using appropriate key words. (3-4 site visits)
5.3 Discuss the importance of structuring the search phrase and the use of *Boolean Operators* to narrow the search. Eg. *And, Or, Not* etc.	5.3 Continue research using focused search strings and intelligent choice of key words. (5-6 site visits)
5.4 Encourage participants to print out relevant information for later use.	5.4 Print out any material that assists in answering any of the three key research questions.

Discuss/Consider:

- The importance of focused research.
- The use of Boolean Operators to assist in defining key word searches.
- How much time do you have? Setting a realistic time limit for research.

Tips and Tricks:

- Facilitators may choose to present the 3 key research questions on an overhead transparency for ease of reference for the participants. See: Attachment (OHT) 5.2 *Internet Focus Questions*
- Facilitator may wish to have previously book-marked the following Internet sites and/or have them cached on the server for faster access times.

  www.uio.no/~walmann/Master/node24.html

  www.scimedia.com/chem-ed/optics/detector/ccd.htm

  www.apogee-ccd.com/ccd103.html

  www.dalsa.com/

- Other possible www addresses:
  http://www.oceanoptics.com/ccd.asp
  http://www.skypub.com/imaging/ccd/ccd.shtml
  http://www.plustekusa.com/info/pixel.html
  http://www.hvwtech.com/learning.htm#video

Activity 6.0: Sourcing additional information

Purpose: To provide participants with additional information sources for research on cutting edge science topics.

Teaching Procedures: "Brain-storming" activity – group discussion/reflection

Time allocation: 10 minutes

What to do

FACILITATOR	PARTICIPANT
6.1 Ask participants to suggest additional sources of information for researching a cutting edge science topic. Where do they go for information?	6.1 Suggest and discuss relevant information sites.
6.2 List suggestions on the white board for further discussion and for participants to reference.	6.2 Note suggestions for future reference.

Discuss/Consider:

- E-mail discussion groups and automated news groups e.g. PEN (Physics Education Network) distributed by American Institute of Physics, and "The Electronic Journal of Science Education", University of Nevada.
- Subject associations' e.g. STAV, Australian Journal of Science Teachers etc.
- Science based magazines e.g. New Scientist, Popular Mechanics, Australian Horticulture etc.
- Newspapers and Radio programs eg "The Science Program" – ABC Radio National.
- "Ascent" is a quarterly technology magazine produced by the Corporate Communications Section of the Department of Industry, Science and Resources. It focuses on technological applications of cutting edge science. For subscriptions contact Naomi Weatherby Ph: (02) 6213 6300.

Tips and Tricks:

- Each participant should be encouraged to share his or her own information sources.
- Attempts should be made by the facilitator to "value" the information sources suggested by each participant.

Activity 7.0: Designing classroom activities

Purpose:

- To provide participants with the opportunity to share and interpret the information they collected during Activity 5.0
- To encourage participants to design suitable classroom activities to address the key research questions identified during Activity 5.0

Teaching Procedures: Translation task, Group work

Time allocation: 30 minutes

What to do

FACILITATOR	PARTICIPANT
7.1 Suggest the participants divide into three equal groups and design an activity or task suitable for CSF level 6-7 which will assist students to answer one of the three key research questions identified in Activity 5.0.	7.1 Selects one of three groups. Each group focuses on just one of the key focus questions from Activity 5.0
7.2 Suggest that participants share their information collected in Activity 5.0	7.2 Share and interpret information collected by the group members relevant to the focus question.
7.3 Stress the importance of designing an activity, which focuses on a task rather than just fact/content presentation.	7.3 Contribute to group formulation of a student task or class activity.

Discuss/Consider:

- Intelligibility of the content.
- Dependence on students' prior knowledge, understanding and science experience.
- Problems of student cognitive overload.
- Difficulties associated with student engagement.

Tips and Tricks:

- Facilitator to ensure that each group chooses a different focus question.
- Ensure that the groups remain on task, as time may prove short for this activity.
- Check each group's progress 10 minutes before the suggested end of the activity to help focus each group's member's attention back onto the required task.
- If this activity begins to "drag" then ensure that enough material has been produced for the completion of the activity and use the additional time for Activities 8.0 and/or Activity 9.0

Activity 8.0: Reflecting on group outcomes

Purpose: To provide an opportunity for each group to report on their progress in designing student tasks.

Teaching Procedures: Group discussion and reflection on progress with Activity 7.0

Time allocation: 20 minutes (3x5 minutes + 5 minutes for summing up)

What to do

FACILITATOR	PARTICIPANT
8.1 Co-ordinate reporting back from each of the three groups on their suggested activities and tasks.	8.1 Discuss and contribute suggested activities.
8.2 Ask a volunteer participant to record ideas on the white board for reference.	8.2 Note relevant activities of interest.
8.3 Ask participants, "Which of the questions appears to be the most difficult to design activities for, and why might this might be the case?"	8.3 Reflect and contribute to discussion.

Discuss/Consider:

- Intelligibility of the content.
- Dependence on student prior knowledge, understanding and science experience.
- For students there may be problems associated with cognitive overload and engagement.

Tips and Tricks:

- The facilitator may consider requesting a volunteer from each group to report back to all participants at the end of the activity.
- Participants may be encouraged to record their ideas on overhead transparencies during discussion to assist them when reporting back.
- Let the participants be responsible for managing the reporting back. Recall skills of withholding judgement, increasing wait time etc.

Activity 9.0: Some alternative activities

Purpose: To provide participants with additional activities which help to demonstrate alternative approaches.

Teaching Procedures: Discussion and evaluation of sample worksheet,
Attachment 9.1 *"Exploring a Digital Camera"* and a POE,
Attachment 9.4 *"Spectral Sensitivity of a CCD"*.

Time allocation: 15 minutes (10 minutes for handout + 5 minutes for POE)

What to do

FACILITATOR	PARTICIPANT
9.1 Present Attachment 9.1 as an example of an activity, which had been prepared earlier.	9.1 Read and critically evaluate the activities in Attachment (9.1)
9.2 Ask the participants to consider which of the three key questions in Activity 5.0 this activity is focused on. Use Attachment 5.2 as OHT.	9.2 Consider question and discuss.
9.3 Invite critical comments on the suitability of the suggested activities.	9.3 Reflect and contribute to group discussion.
9.4 POE – Present Attachment 9.4 on the spectral sensitivity of silicon based CCD and discuss the information it displays. Then ask the participants to predict what a digital camera will observe if it focuses on an active infrared remote control devices?	9.4 Consider and predict an outcome.
9.5 Perform the demonstration and ask the participants to observe and explain the results.	9.5 Discuss and explain the observation.

Discuss/Consider:

- The suitability of the suggested tasks. Would they work in your class?
- The colour of the infrared beam detected by the video unit.

Tips and Tricks:

- The P.O.E. works best in a semi-darkened room although this is not necessary if the remote unit is pointed directly at a well-focused camera. A small lens or magnifying glass may be placed in front of the remote unit to enhance the appearance of the beam.

- It is important for the facilitator not to interpret or explain what was observed. If time permits get the participants to write down what they saw as accurately as they can and then discuss what was observed. This will often lead to surprising results.

- The infrared beam appears white because of its intensity. It saturates or "overloads" the CCD because of its sensitivity to infrared radiation (light/heat). Some cameras also use infrared blocking filters to compensate for the greater sensitivity of the CCD to infrared radiation. This avoids all images becoming bathed in a red glow from background infrared radiation that may be present.

Activity 10.0: Researching your own cutting edge science topics

Purpose: To encourage participants to identify and research their own cutting edge science topic and incorporate it into their current teaching practise.

Teaching Procedures: Planning a research activity.

Time allocation: 5 minutes

What to do

FACILITATOR	PARTICIPANT
10.1 Again revisit the suggested cutting edge science topics listed by participants in Activity 3.0	10.1 Respond and contribute to discussion.
10.2 Encourage participants to identify a topic that will complement their current science curriculum.	10.2 Choose a topic relevant to their current teaching commitments and curriculum.
10.3 In cooperation, plan a suitable time line for the participants to trial a cutting edge science topic in their school.	10.3 Plan a time line for a cutting edge science trial.

Discuss/Consider:

- The choice of topic.
- Ability to trial the topic and activities with a class.
- How the sharing of trial material within the group of participants can be achieved.

Tips and Tricks:

- Encourage the participants to form small working groups with common topics for trial.
- Participants may wish to share e-mail addresses to remain in working contact during the trial and sharing of materials.

Module Review

Between Session Tasks:

Participants are requested to:

- Identify a cutting edge science topic appropriate for study with a current science class for presentation in the near future.
- Research material on the identified topic and devise a suitable classroom activity for the introduction of the topic.

Support Materials:

Attachment 1.3
- *"Taking Charge" – A current issue.*

Attachment 5.2
- Use as Attachment or OHT for "Research Questions" used in Activity 5.

Imaging technology web sites:

- www.uio.no/~walmann/Master/node24.html
- www.scimedia.com/chem-ed/optics/detector/ccd.htm
- www.apogee-ccd.com/ccd103.html
- www.dalsa.com/

Attachment 9.1
- *"Exploring a Digital Camera"* - Sample Activity

Attachment 9.4
- *"The Spectral Sensitivity of a CCD"*