MODULE CONTENT

Module Title: # LAB WORK – REALITY AND POTENTIAL

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Module Description:

Lab work is a common and accepted part of science and it is often assumed that it provides an effective learning experience. However, in comparison to general expectations, its effectiveness is often questionable. This module examines and elaborates upon some possible unrecognised learning problems associated with lab work, and expands the repertoire of effective procedures suitable for lab/practical work.

Summary of Activities:

	Title	*Min*
1.0	Believing is Seeing	15
2.0	Too Much Too Soon	30
3.0	Walk this Way - Part 1	15
4.0	Walk this Way - Part 2	10
5.0	The Speed of Sound – Part 1	35
6.0	The Speed of Sound – Part 2	25
7.0	Three Procedures	30
	Total	160 mins

Module Outcomes:

- To experience the use of a POE (Predict Observe Explain) procedure which can be used to elicit students' prior views and to encourage student interest and engagement with a lab task.
- To broaden participants' views of the range of ways in which prac work can be organised and recorded.
- To enable participants to experience some of the difficulties associated with the assembly and use of an unfamiliar piece of equipment, then reflect on these experiences in the light of similar demands placed on students during lab tasks.
- To introduce participants to different ways of producing and making sense of data collected during prac work.
- To identify some of the challenges faced by students in designing their own investigations and to consider ways of improving student learning in such tasks.

Resources and Materials:

- Two balls that are identical (as far as possible) in every way except mass. (A basket ball/medicine ball or shot put/baseball might be examples that are easy to obtain).
- A sand tray with sand.
- CBL equipment from Texas Instruments (This MUST be organised **one month in advance**. See details in Attachment 2.0).
- Overhead Projector.
- Paper (A4 for creative writing and experimental design).
- White Board marker.
- Attachment 2.0 – Order Form to borrow equipment.
- Attachments 2.1, 3.1 (1 per pair).
- Attachment 6.1 (1 per group of 3).
- Attachments 7.1, 7.2, 7.3 (1 per person).
- OHT 3.1.

Activity 1: Believing is Seeing

Purpose: This is a diagnostic procedure that is used to encourage personal interest in, and cognitive engagement with, a prac task. It also highlights some of the difficulties associated with observation in science.

Teaching Procedures: POE

Time allocation: 10 minutes

What to do

FACILITATOR	PARTICIPANT
1.1 Stand on a table holding two balls of identical size. Describe the balls as identical except for their weight*. Prepare to drop balls from an equal height into a tray of sand on the floor. Pose the question to participants, "Which ball do you think will hit the ground first?"	1.1 Predict which ball will hit the ground first.
1.2 Ask participants to close their eyes then indicate by raising hand which ball will arrive first. Collate responses on board. Some reasons can be gathered from volunteers about why they have taken a particular decision.	1.2 Participants to indicate by raising hand which ball landed first. Collate numbers of responses on board.
1.3 Carry out the demonstration. Collate numbers of responses on board.	

1.4 Encourage participants to consider differences between observation and prediction. • "What did you see? • Is that what should happen?" (Aim to ask for ideas from groups where prediction and observation were the same and where prediction and observation differ).	1.3 Offer ideas about prediction compared with observation.
1.5 Facilitator asks: How did you know what was supposed to happen?" (Ideas include personal experience, read in book, learned at school, etc.) Tell participants that Galileo did not drop balls from the tower of Pisa - that is a myth! Why do many people believe this?	1.4 Respond and discuss.

Discuss/Consider:

- What was the effect of asking participants to make a prediction prior to the event? (The idea of personal interest and engagement through involvement is an important aspect of POE's).

- People have described a range of observations for the same event. How is it that two people can "see" exactly the same event differently? (Facilitator should aim to draw out ideas that people see what they think they "should" see based on prior knowledge, experiences).

- A common task for students in prac work is to "describe what you see" or "record your observations". What are the implications of this activity in terms of these expectations? (Some good examples to draw on here would be observations through the microscope - students draw air bubbles or "messy" lines instead of neat cells; also in measurement where need for precise measurements can bring a range of results).

Tips and Tricks:

- * The word weight rather than mass may help some people to feel more comfortable with the activity.
- It may be helpful to appoint someone to collate responses, at least initially.
- It is important to practice this activity a few times before hand.
- There is value in only doing the demonstration once, so as to provide participants with only one episode to draw from, to reduce confusion.
- Participants should be able to clearly distinguish between the two balls.
- Consider what you would do if <u>everyone</u> sees one ball clearly hitting the sand <u>first</u>.
- The point of this task is <u>not</u> to spend time discussing the physics of the ball drop, but to see that individuals view the same event differently. The choice of POE is based on the use of everyday materials and an often taken-for-granted event, which in reality is a great deal more complex than is commonly acknowledged.

Activity 2: Too Much, Too Soon

Purpose: To experience the effects of receiving too much information too quickly in science (cognitive overload) and to reflect on ways that this might be reduced in prac classes.

Teaching Procedures: Work Out What You Need to Find Out

Time allocation: 30 minutes

What to do

FACILITATOR	PARTICIPANT
2.1 Provide participants (in pairs) with a motion sensor, graphic calculator and a copy of the instructions from Texas Instruments manual * re how to set up a motion sensor for use. See Attachment 2.1. 2.2 Participants are asked to assemble sensor so that it works. (Set a time limit of 10-15 mins.) Offer minimal assistance and take note of the different approaches taken by pairs. 2.3 Re-form large group. Encourage pairs to talk about the approach they used to set up equipment and their success or otherwise in setting it up. 2.4 Ask, "What factors were most helpful in promoting success?"(Consider familiarity with equipment, familiarity with terminology, clarity of instructions, type/extent of small group discussion, way in which group members participated). 2.5 Ask how the roles were assigned in the group. What roles did people take on and why? If in mixed groups who set up and used equipment? Was this agreed upon or did it just happen?	2.1 Pair up and set up motion sensor.

Discuss/Consider:
Facilitator draws a parallel between this activity and the tasks that students are expected to carry out as part of lab work. Learning what the teacher intends may be neglected because students are busy learning how to use the equipment, and how to interpret and follow procedures.

- How is this activity similar to the ways in which students in your class experience new equipment/new procedures?
- What are some of the ways of addressing the possible difficulties students may face in coping with information overload? (Suggestions include giving students time to familiarise themselves with equipment first).
- Why would a student be interested in learning about how to use a motion sensor? What are some real world examples of their use? (Examples are security systems, home alarms, and Travel time studies eg. TAC, RACV)

Tips and Tricks:

- * The instruction sheet provided in hard copy as Attachment 2.1 is a synthesis of selected sections from the Texas Instruments handbook, and does not appear exactly in this form in the handbook. It has been derived to demonstrate cognitive overload.
- Equipment must be ordered from Texas Instruments **one month in advance.** (See advice in Attachment 2.0 for order details.)
- Facilitator needs to practice using equipment beforehand in order to feel confident about set up.
- Ensure Ranger program is not preloaded into the calculator.
- Facilitator needs to organise group size according to available equipment.
- Facilitator should be mindful not to provide too much assistance. Participants should struggle to gain maximum value from the experience!

Activity 3: Walk this Way – Part 1

Purpose: To encourage greater thinking and involvement in prac work through a translation task which uses a data logger and motion sensor. Also, to provide an example of one way in which students can get a physical sense of data.

Teaching Procedures: Translation task

Time allocation: 15 minutes

What to do

FACILITATOR	PARTICIPANT
3.1 Provide a motion graph to each pair of participants. (Each pair is given the same graph) See Attachment 3.1.	3.1 Participants discuss in pairs what the graph shows and practise how they would walk the graph.
3.2 Ask for volunteers who are prepared to walk their graph in front of the motion sensor. Choose three pairs. Ask two pairs to leave the room, so that each pair can be called in to walk the graph separately.	3.2 One person from first pair walks the graph in front of the data sensor.
3.3 Place transparency of the d/t graph over the graph plotted by the data sensor to compare the two. See OHT 3.1.	
3.4 The next two pairs of volunteers are called in separately to walk the graph in front of the motion sensor.	3.3 Persons from other pairs walk the graph.
3.5 Ask for a final volunteer from the group within the room who can correctly walk the graph.	

Discuss/Consider:

- What is the value in doing an activity such as this? (Explore the idea of the use of a data logger as well as translating a graph as a physical activity).
- What was the effect of using human bodies in walking the graph, rather than using something small like toy cars? (The effect of feeling the movement can be discussed).
- Why were the volunteers kept outside the room? What effect did this have on the activity?

Tips and Tricks:

- Depending on the experience and confidence of the group, the facilitator may choose the following as an extension or alternative activity. Two people are nominated to leave the room, while the rest of the group creates a graph on the motion sensor. The two people are called in and try to walk the graph.
- This activity could be set in the context of an accident. Participants could be acting out the scene of an accident for accident research.

Activity 4: Walk this Way - Part 2

Purpose: To demonstrate the use of a translation task (Creative Writing) as a way of processing data gathered from a lab task. The function and acceptability of different types of writing in prac tasks is also considered.

Teaching Procedures: Translation Task

Time allocation: 10 minutes

What to do

FACILITATOR	PARTICIPANT
4.1 Using the same data (replace OHT 3.1), ask participants to write a short imaginative story which uses and is consistent with the data presented on the graph. (Encourage poems, songs, etc.) Constraints are that the story must include an animal and an accident.	4.1 Individually write a short piece using the data. 4.2 Volunteers read out the story they create.

Discuss/Consider:

- Both this activity and the previous one (Part1) involve making sense out of data. Discuss the kinds of learning that each task requires. (Both activities require interpretation of data, one physically, one in writing).

- Is one style of writing more appropriate/acceptable in science than other forms? (For example, is report writing "real" science writing?) What is the place of creative writing in science?

Tips and Tricks:

- Two or three volunteer readers will be sufficient.

- It is a good idea for the facilitator to also participate in the writing exercise. Depending on the available time, some discussion of the powerful effects of teacher “modelling” can be discussed.

- This activity could also be set in the context of accident research. The creative writing may take the form of a police or insurance report. This builds the idea of a story that is constructed from available evidence.

Activity 5: The Speed of Sound – Part 1

Purpose: Activities 4 and 5 provide participants with an opportunity to examine some of the issues related to the design of prac work that promotes student involvement and meaningful learning. Participants experience some of the challenges of designing a prac that involves a large group.

Teaching Procedures: Deduce prac design from limited information

Time allocation: 40 minutes

What to do

FACILITATOR	PARTICIPANT
5.1 Introduce activity as one that involves measuring the speed of sound. Ask participants why someone might want to know the speed of sound? What impact does such knowledge have on people?	
5.2 Organise participants into small groups.	
5.3 Tell each group that they have 10 minutes to design an experiment that would involve a whole class of students in a prac to accurately measure the speed of sound. (Assume junior to middle school students, if the question arises.) The experimental design needs to be recorded in writing.	5.1 Design and write up experiment.

5.4 Ask each group to pass their written prac design to another group. Each group should identify: ▫ Two main problems ▫ One good feature of the experimental design that they have received. (Set a 10 minute time limit).	5.2 Exchange experimental designs. Provide written critique.
5.5 Organise small groups so that they can discuss critiques with each other, as appropriate. (Set a 10 minute time limit to present and receive a critique).	5.3 Discuss in groups.
5.6 Ask whole group for feedback regarding some of the features identified.	

Discuss/Consider:

- What were some of the difficulties that groups encountered in designing a prac? (Ideas include ways of meaningfully including the whole class, designing a do-able experiment especially in terms of large distances required, minimising error, repeating measurements.)

- In what ways could the prac be modified to maximise learning and involvement? (For example having defined roles for students, students being briefed well before going outside, video taping event to watch again inside or for use at other times.)

- What do you do with the data once it has been collected? (Suggestions might be to compare results and look for possible sources of error, to compare with scientifically accepted speed of sound, ask why we would want to know the speed of sound, real world applications.)

Activity 6: The Speed of Sound - Part 2

Purpose: To become aware of some of the challenges faced by students in designing their own experimental investigation. Also, to consider approaches which can be used to enhance student learning from prac work.

Teaching Procedures: Deduce prac design from limited information

Time allocation: 10 minutes

What to do:

FACILITATOR	PARTICIPANT
6.1 Hand out to each small group sample pracs that that have been designed by year 7 students in response to the task: "Design an experiment that could be used to measure the speed of sound." (Explain that students did not have to involve the whole class in their experimental procedure). See Attachment 6.1 for prac samples.	
6.2 Ask groups to read and discuss student samples, commenting on experimental design and apparent understanding of task. (Allow 10 minutes).	6.1 Read and discuss students' prac designs. Each group should keep a written record of discussion points.
6.3 Ask participants in whole group discussion to comment on design/identify some of the difficulties they saw.	6.2 Respond in discussion

Discuss/Consider:

- What are some of the difficulties that these students seem to have encountered?
- What sense do they have of experimental design?
- What activities do you think you could use before (or after) designing the prac that would help students to think through some of the potential areas of difficulty? (Some suggestions are checking that students understand the purpose of the task, that they have some understanding of a scientific approach e.g. identifying, controlling variables, and repeating measurements, that they have sufficient background content knowledge appropriate to the investigation).

Tips and Tricks:

- It will be most helpful to have an even number of groups for the initial prac design activity. Otherwise swapping over can be problematic.
- Small groups feedback information to each other rather than as a whole big group so those individual design features can be discussed. It also creates a less threatening environment for sharing critiques.

Activity 7: Three Procedures

Purpose: This activity will enable participants to experience three different approaches to the organisation of prac work each of which is intended to enhance students' interest and promote deeper levels of thinking about the tasks they are doing.

Teaching Procedures: Sort out Jumbled Notes or Instructions

Time allocation: 30 minutes

What to do:

FACILITATOR	PARTICIPANT
7.1 Organise participants into three groups. Each group needs a separate workspace. Explain that participants will be involved in three different activities. Each activity is designed to encourage greater engagement with the purpose and design of prac tasks. (Approx. 10 mins should be spent on each of the activities.) 7.2 Give out instructions for one different activity to each group. See Attachments 7.1, 7.2 and 7.3 for activity sheets. 7.3 After each 10 minute interval ask the groups to finish and move to the next work station.	7.1 Complete activity according to the instructions provided.

Discuss/Consider:

- What were the different learning demands of the activities? (Suggestions include the need to think about what is being presented, to ask questions about the material, to work as a group in exchanging ideas, the need to know something about the material being presented in order to make sense of it.)
- What is the purpose of these types of activities?
- What would encourage students to engage in these kinds of activities? (Encourage discussion about ways to engage students in the task beyond simply presenting it as something to be completed.)

Tips and Tricks:

- This could be done as a whole group activity with everyone doing the same thing at the same time. However, dividing into smaller groups and moving around the room shifts the focus from the facilitator and enliven participants (hopefully?) as they move to a different space to begin a different task.
- Consider enlarging each diagram on to an A3 sheet.
- An important purpose of this activity is to highlight some of the difficulties that students encounter when presented with complex equipment and/or diagrams.

Module Review

Between Session Tasks: Ask a trusted colleague to come into your classroom while you are conducting a prac class. The colleague should walk around the room informally asking students what they are supposed to be doing, why they are doing it and how it fits into their current science work. Questioning should try to push students' responses beyond the superficial; for example "We're doing a prac on cells." At the end of the prac class, teacher and colleague should discuss mismatches between teacher and student perceptions of the aim of the prac and its purposes within students' current science learning.

Support Materials:

Berry, A, Mulhall, P, Gunstone, R and Loughran, J (1999). Helping Students Learn from Laboratory Work *Australian Science Teachers' Journal*, *45*(1), 27 – 32.

The Project Physics Course, Book 5, Models of the Atom, 1974, Page 39, Educational Division, Horwitz Group Books Pty. Ltd

S. L. Martin & A. K. Connor, Basic Physics, Book 2, Page 809, Whitcombe & Tombs Pty. Ltd.

Roger Muncaster, (1981). A level Physics, Pg 652, Stanley Thornes.