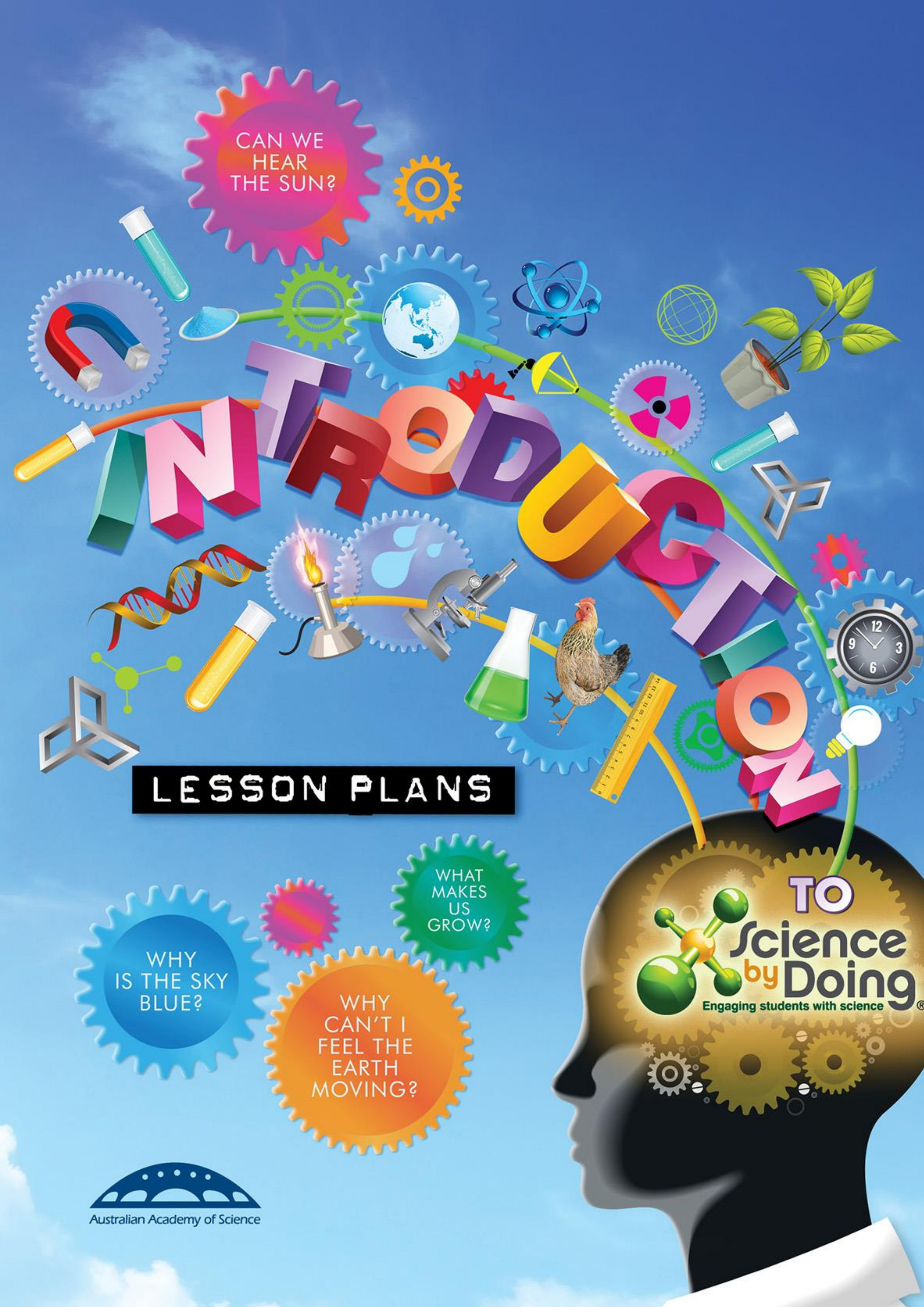

CAN WE HEAR THE SUN?
INTRODUCTION
LESSON PLANS
TO
Science by Doing
Engaging students with science
WHAT MAKES US GROW?
WHY IS THE SKY BLUE?
WHY CAN'T I FEEL THE EARTH MOVING?
Australian Academy of Science

1.1 What is science?

Lesson outcomes

At the end of this activity students will be able to:

- identify key aspects of the scientific process; including observing, wondering, asking questions, thinking logically, making hypotheses, testing, and finding answers
- design a simple investigation to test a hypothesis.

Key vocabulary

Observation, inference, hypothesis (plural – hypotheses), ponder, postulate, predict, bar graph, line graph, pie chart.

EQUIPMENT LIST

Each GROUP will require:

- various simple pieces of equipment depending on the investigation. Possibly graph paper.

Each STUDENT will require:

- access to an animal to study. This can be simply achieved using ants, flies, or other insects, chickens or the family pet.
- ***Notebook***
- *Student Guide*
- Internet access
- **Activity sheet 1.1 Interpreting graphs** (in Activity 1.1 of Teacher Guide)

Things to consider:

For the main activity, students are asked to study an animal. Keep it simple. Some will have chickens or small animals. Others could study ants or houseflies in their natural habitats. Interesting observations can be made of snails, particularly as they move on glass. The response of ants in a nest in the school grounds to a new food source could be studied as a mini field trip. You can adjust the steps provided below according to whether you would like the students to complete the activity in class or at home, and to allow students' own questions to be investigated.

The buoyancy video provides students with an opportunity to make a prediction and then to watch the outcome. The outcome asks them to attempt an explanation for what they observe. The scientific accuracy of this explanation is not the main point, as long as they attempt to come up with what they think is a plausible explanation.

The ***Notebook*** task presents three videos illustrating different approaches to scientific study. Students note what tasks the scientists do in their research. Some science relies on observation data whereas other research requires collecting samples or the use of laboratory equipment.

Lesson plan:

Step 1: Collect questions from the whole class. Record these questions on the board or use butcher paper so that they can be displayed.

Step 2: Allocate an animal to each group and ask them to identify a simple question to ask or observations that could be made. Discuss the best way to present their results.

Step 3: Allocate each group a question that can be easily researched experimentally in the classroom in a single lesson.

Step 4: Present the graphing activity, **Activity sheet 1.1 Interpreting graphs** (provided in Activity 1.1 of the Teacher Guide), in preparation for **Activity 1.2**.

1.2 What measures up?

Lesson outcomes

At the end of this activity students will be able to:

- design an experiment to test a simple hypothesis
- present results in table or graph form.

Key vocabulary

Experiment, aim, method, results, testing.

EQUIPMENT LIST

Each GROUP will require:

This will vary, depending which hypothesis each group chooses, but the requirements are basic, and do not require specialised equipment. Most groups will require graph paper.

Each STUDENT will require:

- ***Notebook***
- *Student Guide*.

Lesson plan

Step 1: Present the hypotheses to the class and allow each group to choose one.

Step 2: Allow groups 10-15 minutes to design a simple experiment.

Step 3: Allow groups about 20-30 minutes to conduct the experiment and record the results. Some groups may need additional time and/or collect data at home.

Suggested question/s:

1. What scientific skills did you use in this activity?

2. How did you present your results?

3. Did your results support the hypothesis?

2.1 Safety in the laboratory

Lesson outcomes

At the end of this activity students will be able to:

- identify appropriate laboratory safety rules and reasons for their adoption
- complete a simple risk assessment.

Key vocabulary

Risk assessment, exits, fume cupboard, eye wash, safety blanket, fire extinguisher, radiation, biohazard, corrosive, flammable.

Things to consider

The 360° video *An afternoon in a Plant Energy Laboratory – Plant Energy Biology 360°* can be viewed differently on different devices.

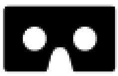
To view on a personal computer or laptop:-

- Click on the 360° video link to open *An afternoon in a Plant Energy Laboratory – Plant Energy Biology 360°*
- Click and drag to look around the lab

To view on a Smart Phone or iPad/tablet:-

- Open the YouTube app on the device
- Search for and select *An afternoon in a Plant Energy Laboratory – Plant Energy Biology 360° video*
- Move device for 360° viewing

To view on a Smart Phone with a cardboard headset (immersive viewing) you will need:-

- Open the YouTube app on the smart phone
- Search for and select *An afternoon in a Plant Energy Laboratory – Plant Energy Biology 360° video*
- Tap the cardboard icon 
- Insert into cardboard headset for 360° viewing

Teacher content information:

This activity has two components:-

1. For students to understand why so much science is done in laboratories. This is often considered simply a stereotype, but there are good justifications:
   a) the need for tightly controlled conditions and specialised equipment for many experiments
   b) safety.
2. This activity also includes a simplified risk assessment. Students use **Activity sheet 2.1 Risk assessment (**in **Activity 2.1** *Teacher Guide***)** in order to conduct a risk assessment of the coming experiment in **Activity 2.3**.

Common school laboratory safety rules can be adapted to your own laboratory:

1. Wear an apron and safety glasses at all times when conducting experiments.
2. Wear covered shoes at all times in the laboratory.
3. Tie long hair back when using a Bunsen burner.
4. Eating and drinking are strictly prohibited in the laboratory.
5. Consider all chemicals hazardous, unless otherwise instructed.
6. Never run or throw things.
7. Know the location and use of safety and first-aid equipment.
8. Never point a test tube, which you are heating, at yourself or your partner.
9. Avoid contamination of reagents. Always use a clean stirring rod, take only the amount of chemical needed and never return unused reagents to the bottle.
10. Always replace the lid on the reagent bottle immediately after use.
11. Sweep up all broken glassware immediately.
12. Always read the instructions carefully and ensure you know exactly what you are meant to do **BEFORE** you begin any experiment.
13. Strictly follow instructions outlined for experiments – no unauthorised experiments are permitted.
14. Keep your work area clean and tidy. Your bag should be placed out of the way, under your bench.

Lesson plan

Step 1: Discuss with the class why so much science is done in laboratories and the image showing multiple unsafe practices.

Step 2: Discuss with the class how the school laboratory allows scientific experiments to be done, covering specialised equipment, water, gas, electricity and safety. Students will devise a set of safety rules for their laboratory.

Step 3: Students draw a diagram of their own laboratory in their ***Notebooks***, indicating safety equipment, such as blankets, showers, fire extinguishers, gas and water shut-offs.

Step 4: Students test their knowledge of safety labels in a drag and drop activity.

2.2 Using laboratory equipment

Lesson outcomes

At the end of this activity students will be able to:

- safely light a Bunsen burner
- identify standard laboratory equipment and describe its use
- draw labelled pencil diagrams of scientific apparatus.

Key vocabulary

Reagent, gauze mat, Bunsen, Bunsen burner, retort stand, boss-head, clamp, test-tube holder, measuring cylinder, stirring rod, watch glass, crucible, conical flask, beaker, test tube, filter funnel, evaporating basin.

Things to consider

- If your school has a system of issuing Bunsen licences to students this would be an appropriate place to integrate this.
- Many students have difficulty safely lighting matches.

Lesson plan

Step 1: Demonstrate the safe lighting of a Bunsen burner.

a) Attach the Bunsen burner gas hose securely to the gas tap.

b) Ensure the air hole is closed on the Bunsen burner.

c) Light the match first and hold it horizontally to slow its burning.

d) Turn on the gas.

e) Light the gas.

f) Open the air hole to demonstrate the hotter flame.

g) Return to air hole to closed when Bunsen burner is not being used. This is called the safety flame because it is cooler and more visible.

h) To turn off the Bunsen burner turn off the gas tap.

i) Put any dead matches into the bin.

Step 2: Use the *Student Guide* and 'How to light a Bunsen burner' video to reinforce the demonstration before allowing students to practice lighting their Bunsen burners.

Step 3: Present the videos on 'Safety dress' and 'Lab glassware' before putting students onto the drag-and-drop activity where they identify basic laboratory equipment.

Step 4: Consolidate the learning of the laboratory equipment in the ***Notebook*** task where students name and describe the use of laboratory equipment beside schematic diagrams of each.

Step 5: Introduce students to scientific drawings on page 14 of the *Student Guide* and ask them to draw a labelled schematic diagram of the apparatus shown in their ***Notebooks***.

2.3 Where do the water droplets come from?

Lesson outcomes

At the end of this activity students will be able to:

- safely carry out a simple experiment involving hot water and safely lighting a Bunsen burner
- draw possible inferences and propose a hypothesis based on observations.

Key vocabulary

Condensation, observation, inference, hypothesis, experiment.

What ideas might your students already have?

Students will be confused about how water condenses and how it can appear from nowhere. They do not know that air contains invisible water vapour or that water could be a product of a chemical reaction.

Things to consider

One of the most creative aspects of scientific work is the generation of new hypotheses. This activity '*Where do the droplets come from?*' provides students with some experience of how scientists do this, based on careful observation. It also gives them the experience of applying their reasoning to identify the most plausible hypothesis based on their observations.

Teacher content information:

Where do the water droplets come from? - this phenomenon is easily observed in the kitchen where condensation will immediately appear on the outside of a saucepan of cold water put on a gas burner. This will not happen using an electric hotplate. Water is a product of the combustion of any organic fuel, including natural gas. As this comes into contact with the cold saucepan, it condenses. The effect disappears quickly as the saucepan heats up. The answer is that water droplets came from the burning gas, an inference made based on the observations.

As you teach:

Step 1: Students carry out the activity '*Where do the water droplets come from?'*

Step 2: Discuss with the class their observations and possible inferences that could be drawn. Compare these with those proposed by students in the digital link:-

- Water from the air has condensed on the saucepan
- Water has seeped out through the side of the saucepan
- Water has somehow moved over the edge of the saucepan to the outside
- Water has condensed from the burning gas

Step 3: Discuss with the class which possible inference they think provides the most likely explanation. Can they think of an experiment to test this hypothesis?

3.1 How do you learn best?

Lesson outcomes

At the end of this activity students will be able to:

- identify strategies that could be applied to improve their own learning in science
- understand the role of different memory components and how they help us gather and retain new information.

What ideas might your students already have?

Students may have had little exposure to ideas of how they learn, or that there are strategies to take control of their own learning.

Key vocabulary:

Working memory, long term memory, attention, metacognition.

EQUIPMENT LIST:

Each STUDENT will require:

- ***Notebook***
- *Student Guide*
- Internet access

Things to consider:

The class memory activity gives students insight into the importance of strong connections and meaning in their learning. Making sense of what they are learning is vital. Rote learning of material that makes no sense, within the mental models they already have, is rarely successful.

Teacher content information:

- Refer to **Part 2.6** in the *Inquiry DIY Guide* for a full description of the 5Es model as applied to the *Science by Doing* program. The information about memory has been introduced early to expose students to the idea that learning and memory are just one part of their own physiology, and that their decisions affect their capacity to learn. It is hoped students will achieve some level of metacognition and take more responsibility for their own learning.
- Some of the material has been taken from John Medina's *Brain Rules*. Medina directs the *Brain Center for Applied Learning Research* at Seattle Pacific University. Visit http://www.brainrules.net/the-rules for much of this material.
- ***Concept Mapping*** is used widely in science education. It provides an important mechanism for students to explore and explicate their own understanding. A brief explanation is provided in **Part 3** of the *Science by Doing* unit *Inquiry-based teaching: A stimulus for professional discussion*. Joseph Novak is a key researcher in this field, who provided a concept mapping system closely aligned with the structure of scientific knowledge. His website is available at http://cmap.ihmc.us/Publications/ResearchPapers/TheoryCmaps/TheoryUnderlyingConceptMaps.htm
A presentation on concept mapping is available at http://www.bing.com/videos/search?q=novak+concept+mapping+video&qpvt=novak+concept+mapping+video&FORM=VDRE#view=detail&mid=CC78AFE24806F67B2C57CC78AFE24806F67B2C57

- The n-back task is widely used to study working memory. Studies suggest our working memory capacity increases throughout childhood and adolescence, peaking during the 20s at about six or seven concurrent items. Sadly for us teachers, it then declines over subsequent decades. We overcome this, however, by chunking information, reducing the number of items we need to deal with at once, while achieving the same outcome. There is also evidence that working memory capacity can be increased through practise, but it is uncertain if this would improve overall educational outcomes.

Lesson plan

Step 1: Discuss with the class what each stage in the 5Es model might involve.

Step 2: Read the first pages with your class and discuss the different stages of the 5Es approach.

Step 3: Students should read the pages on memory and then complete the ***Notebook*** activity, noting how these ideas could apply to their own learning.

Step 4 (optional): Students enjoy playing the n-back task as a class or in groups.

Class memory activity

Step 1: Set up two matching trays of 15 pieces of science equipment. Make sure the trays are covered so equipment is concealed.

Step 2: Divide the class into two groups. Tell the whole class students must memorise the contents of the tray they observe. They will have one minute to examine them.

Step 3: Have one group examine the tray on the teacher’s desk, while the second group examines the tray on a bench at the back of the room.

Step 4: The two groups receive different instructions. Group one is allowed to look at the items, but not touch or discuss them. Group two is allowed to touch the objects and encouraged to discuss names and uses.

Step 5: After one minute remove the trays and ask students to return to their desks and write down all objects. During this task, they should not talk or compare notes.

Suggested question/s:

In your ***Notebook*** write ideas gained from this unit about how you might improve your own learning in science.

3.2 Inquiry science

Lesson outcomes

At the end of this activity students will be able to:

- understand the central role of questioning, both in doing science and learning science
- understand aspects of the *Science by Doing* approach and how this relates to the 5Es learning approach.

Key vocabulary

Inquiry, engage, explore, explain, elaborate, evaluate.

EQUIPMENT LIST

This will vary according to teacher specifications – see notes below.

Each STUDENT will require:

- ***Notebook***

Teacher content information:

This activity helps teacher and class work together to become familiar with the structure and approach of the *Science by Doing* program.

Students will consolidate their learning of the 5Es in the *Student Digital* and practise their questioning techniques using open and closed questions. The *Science by Doing* resource on effective questioning is a great resource for teachers.

After completing the *Student Guide* task in their ***Notebooks***, students complete a "science journey of discovery" as determined by the teacher using stations positioned around the room and a variety of tasks.

Students may have had little exposure to learning theories and approaches, and rarely are they given the opportunity to explore objects before generating questions.

Can students justify and elaborate on the correct order for the 5Es? The fifth E stands for evaluation – how can students evaluate what they know at the end of each lesson? (It's not just about student assessment!). What role does the teacher play in consolidating learning outcomes before students leave the classroom?

Things to consider

Provide specific examples to students for the 5Es using the digital resources.

E.g. What does elaboration look and sound like? What is the best way to observe and record data from an experiment (explore)? What does an engaged student look like?

Seek advice and support from your lab technician for the learning stations journey.

Lesson plan

Step 1: This can be a fairly low-key activity, as you complete the first task on the *Student Guide* and watch the video clips with the students. Discuss the sorts of things you will do together over the semester.

Step 2: A science journey of discovery. Use the *Student Guide* to develop ideas for your teacher journey of discovery. Using separate stations around the room (and outside) with students given 5-10 mins at each (depending on number). Your lab technician will help with ideas too!

Suggested question/s:

In your ***Notebook*** write ideas gained from this unit about how you might improve your own learning in science.

Acknowledgements

Project Management

Executive Director: Professor Denis Goodrum, FACE (Australian Academy of Science)
Director of Curriculum Development: Jef Byrne
Web and Digital Co-ordinator: Dr Jen Liu
Education Specialist: Dr Jim Woolnough
Administrative Coordinator: Katie Ryan
Administrative Officer: Kathy Hamilton

Authors

This resource was originally written in 2015 by: Dr Kerrie Wilde and Dr Jim Woolnough

This resource was revised in 2017 by: Dr Jim Woolnough and Jef Byrne.

Science by Doing would like to thank Spinks and Suns for the design and development of this resource.

Funding Acknowledgement

Science by Doing is supported by the Australian Government.

Disclaimer

The views expressed herein do not necessarily represent the views of the Australian Government, Department of Education or Education Services Australia.

These materials are intended for education and training only. Every effort is made to ensure the accuracy of the information presented in these materials. We do not assume liability for the accuracy or completeness of the information contained within.

The Australian Academy of Science accepts no responsibility for any loss or damage whatsoever suffered as a result of direct or indirect use or application of any of these training materials.

ISBN 978 0 85847 511 3
Published by the Australian Academy of Science
GPO Box 783
Canberra ACT 2601
Telephone: 02 62019400
Fax: 02 6201 9494
www.science.org.au.

Click **here** for a full version of unit acknowledgements and sources or logon to www.sciencebydoing.edu.au.


Science by Doing
Engaging students with science
www.sciencebydoing.edu.au